53
8
Illinois U Library

PHYSICS ABSTRACTS

SECTION A

of

SCIENCE ABSTRACTS

SECTION A, PHYSICS

SECTION B, ELECTRICAL ENGINEERING

Edited and Issued Monthly by

THE INSTITUTION OF ELECTRICAL ENGINEERS

In Association with

THE PHYSICAL SOCIETY

THE AMERICAN PHYSICAL SOCIETY

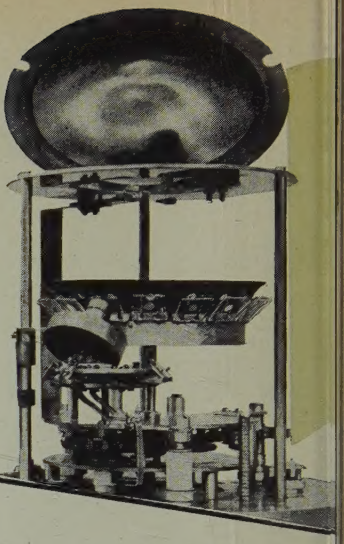
THE AMERICAN
INSTITUTE OF ELECTRICAL ENGINEERS

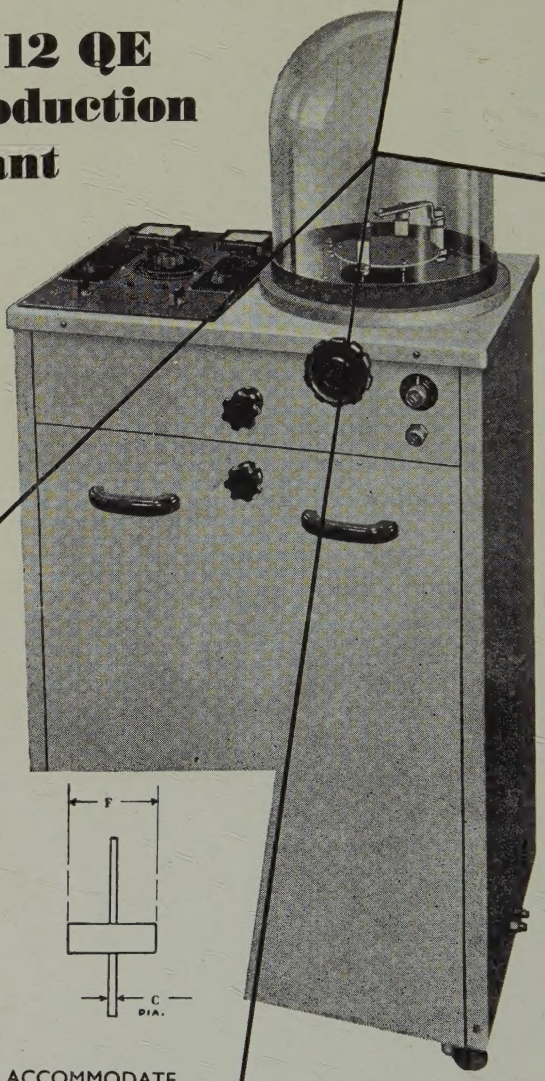
ABSTRACTS 1–575

VOLUME 56 **JANUARY 1953** NUMBER 661

QUARTZ CRYSTAL COATING UNIT

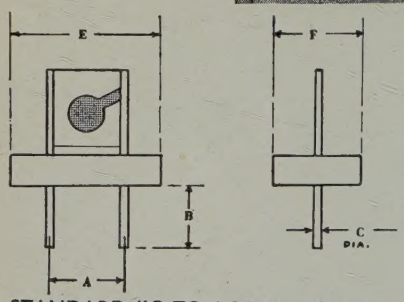
Model 12 QE High Production Plant





This new equi
ment possess
several outstan
i n g d e s i g
features, such a

- A high deposition rate and
of control which permits the
adjustment of crystals already
coated, or the complete co
and final adjustment *in one cy*
- Frequency readings can be t
at any time during the coatin
- A turret head is designed to ac
modate a number of crystals w
are rotated into calibrating pos
by an externally controlled d



A STANDARD JIG TO ACCOMMODATE THE HOLDERS ABOVE IS AVAILABLE

Permissible Tolerances

Tolerance on 'A'	·473″—·501″
Tolerance on 'B'	·125″—·9375″
Tolerance on 'C'	To suit ·093″, ·050″, and ·040″ dia. pins
Tolerance on 'E'	Up to 1·125″
Tolerance on 'F'	Up to ·4375″

(INSET ABOVE)

Photograph of turret head of Model 12QE cover removed from work-chamber.

(CENTRE)

Model 12E; the basic unit of the 12QE in th suitable for the production of coated optics, surface mirrors, rectifiers, photo-cells, forms, shadow casting, etc.

for better vacuum service . . .

W. EDWARDS
& CO. (LONDON) LTD. LONDON, S.E.26

TELEPHONE: SYDENHAM 7026 (8 LINES) TELEGRAMS: EDCOHIVAC, SOUPHONE, LO

Principal Contents

JANUARY 1953

		PAGE
51	MATHEMATICS	17
52	ASTRONOMY. ASTRO-PHYSICS. GEODESY	17
53	PHYSICS	19
530.1	Fundamentals	19
531	General mechanics. Mechanics of solids	22
531.7	Mechanical measurements	22
532	Mechanics of fluids	23
532.6	Capillarity	23
532.7	Molecular theory of liquids	23
533	Mechanics of gases	24
533.7	Molecular theory of gases	25
534	Vibrations. Acoustics	26
535	Optics. Radiation. Spectra	28
536	Heat	37
536.7/.8	Thermodynamics	39
537	Electricity	40
537.1	Theory. Electrons	40
537.2	Electrostatics. Dielectrics	40
537.3	Electric conduction. Currents	41
537.52	Electric discharges	44
537.531	X-rays	46
537.533/.534	Cathode rays. Positive rays	46
537.54	Discharge tubes. Counters	48
537.56/.58	Ionization. Thermionics	50
537.591	Cosmic rays	51
538	Magnetism	53
538.3/.5	Electromagnetism. Electrodynamics	—
538.56	Electromagnetic waves and oscillators	55
538.6	Magnetic effects	57
539.1	Molecular and atomic structure	57
539.11	Theory of solid state	57
539.13	Molecular structure	58
539.15	Atomic structure. Nucleus. Isotopes	61
539.16	Radioactivity. α-, β- and γ-rays	63
539.17	Nuclear reactions	67
539.18	Atom and molecular beams. Mesons. Neutrons	70
539.2	Structure of solids	72
539.3/.8	Elasticity. Strength. Rheology	73
541	PHYSICAL CHEMISTRY	74
541.11/.12	Phase equilibrium. Chemical reactions	74
541.13	Electrochemistry	76
541.14/.15	Photochemistry. Radiation chemistry	76
541.18	Dispersions. Colloids. Adsorption	77
541.2/.6	Chemical structure	77
542.1/.7	Laboratory apparatus	77
542.9	Chemical processes	78
543/545	Chemical analysis	78
548	CRYSTALLOGRAPHY	78
548.7	Molecular and X-ray crystallography	79
55	GEOPHYSICS	81
551.5	Atmosphere. Meteorology	81
57/59	BIOLOGY	83
61	Medical science. Human physiology	83
66/67	TECHNICAL MATERIALS	84
77	PHOTOGRAPHY	84

RELATED SUBJECTS CONTAINED IN SECTION B (ELECTRICAL ENGINEERING ABSTRACTS)

Electrical and magnetic measurements and instruments
Electronic relays and counters
Automatic control mechanisms
Applied electrochemistry
Photocells
Thermionic tubes
Cathode-ray tubes
X-ray tubes
Amplifiers
Radiocommunication
Mechanical engineering
Illumination

Three publications of interest to readers of

'SCIENCE ABSTRACTS'

PHILIPS TECHNICAL REVIEW

A monthly publication dealing with technical problems relating to processes and investigations on Radio and Television, Lighting, Electronics, X-Ray and other allied subjects. 32 pages per issue. Size 11½" x 8". Published in English, French, German and Dutch. Subscription: 21/- per annum (post free).

PHILIPS RESEARCH REPORTS

A publication containing physical, chemical and technical papers, relating to the theoretical and experimental research work carried out in the various Philips laboratories. Philips Research Reports are published in volumes of six issues, each of about 80 pages. Size 9" x 6". Published in English and French. Subscription: 26/- per annum (post free).

COMMUNICATION NEWS

A publication, issued at varying intervals, on transmitters, transmitting valves, line telephony, line telegraphy, and automatic telephony. 32 pages per issue. Size 11½" x 8". Subscription: 14/- per four issues (post free).

All enquiries regarding subscriptions should be addressed to:

PUBLICATIONS DEPARTMENT

PHILIPS ELECTRICAL LTD.

CENTURY HOUSE, SHAFTESBURY AVENUE, LONDON, W.C.2

RADIO & TELEVISION RECEIVERS · TUNGSTEN, FLUORESCENT, BLENDED & DISCHARGE LAMPS & LIGHTING EQUIPMENT · 'PHILISHAVE' ELECTRIC DRY SHAVERS · CYCLE DYNAMO LIGHTING SETS · 'PHOTOFLUX' FLASHBULBS · HIGH-FREQUENCY HEATING GENERATORS · X-RAY EQUIPMENT FOR ALL PURPOSES ELECTRO-MEDICAL APPARATUS · ARC & RESISTANCE WELDING PLANT & ELECTRODES · ELECTRONIC MEASURING INSTRUMENTS · MAGNETIC FILTERS · BATTERY CHARGERS & RECTIFIERS · SOUND AMPLIFYING INSTALLATIONS · CINEMA PROJECTORS · RECORDING APPARATUS

LIST OF JOURNALS

The following list gives the full titles of journals referred to in *Science Abstracts*. It supersedes the list published in January 1950 (contained in Volume 53) and the supplements thereto. The addresses given are believed to be correct at the time of going to press, but no responsibility can be accepted for errors. Changes of address and of title, as well as additions to the list, are published monthly and collated in an annual supplement published with the Index; in the bound volume, the first such supplement will be found preceding this list.

The appearance of a title in this list does not necessarily imply that the journal is received regularly by *Science Abstracts*. Material for abstracting comes from many sources, including borrowed copies of journals and reprints supplied by authors; furthermore, some of the abstracts are reproduced, by permission, from other abstracting periodicals (as indicated at the foot of the abstract) and in these cases the name of the abstracting periodical is given in the list in place of the address of the journal. Particulars of the abstracting organizations are given at the end of this list (and at the end of subsequent supplements).

It should be emphasized that an abstract is only published in *Science Abstracts* when an article or book is believed to be generally available. No abstracts are published of dissertations, reports, or memoranda with limited circulation, unless copies have been deposited with several public libraries; nor of papers presented orally at meetings, unless précis of substantial length are published in the normal way. Thus the appearance of an abstract in *Science Abstracts* may generally be taken as an indication that the original is publicly available, and information for its identification and acquisition, if not given in the abstract, will be found elsewhere in *Science Abstracts*.

The contractions of journal titles used with the abstracts, while following the general form of those in the *World List of Scientific Periodicals* (3rd ed. London, Butterworths Scientific Publications, 1952), differ from them in some cases, to enable the title of the journal to be recognized more readily. General similarity will be found with the contractions used in *Chemical Abstracts*, recently adopted by the journals of the American Institute of Physics. To assist in the interpretation of contracted titles, adjectives are printed with a small initial letter, unless they form part of a proper name.

The form of the "reference," giving volume number, issue number, pages and date, will, it is hoped, be self-explanatory. It should be emphasized that the date given refers, in nearly every case, to the *issue* or *number* containing the article abstracted; in some cases, particularly when papers are issued separately, the *volume* when bound may bear a different date. The date given is that recorded on the issue, not the actual date of publication or receipt, unless so stated. Bold type is used for volume number, or for year when the volumes carry no number.

If no indication of language is given in the abstract, the article may be assumed to be in English. This does not necessarily hold, however, for abstracts reproduced from elsewhere.

A.C.E.C. Charleroi	*Ateliers de Constructions Electriques de Charleroi.* Charleroi, Belgium; A.C.E.C., 56 Victoria Street, London, S.W.1.
A.E.G. Mitt.	*AEG Mitteilungen.* Allgemeine Elektricitäts-Gesellschaft, Hohenzollerndamm 150, Berlin-Grunewald.
A.W.A. tech. Rev.	*A.W.A. Technical Review.* Amalgamated Wireless Australasia, 554 Parramatta Road, Ashfield, Sydney.
Abhandl. Braunschw. Wiss. Gesell.	*Abhandlungen der Braunschweigischen Wissenschaftlichen Gesellschaft.* Geysostrasse 7, Brunswick.
Abhandl. Dtsch. Akad. Wiss. Berlin	*Abhandlungen der Deutschen Akademie der Wissenschaften zu Berlin. Klasse für Mathematik und allgemeine Naturwissenschaften.* Unter den Linden 8, Berlin, N.W.7.
Acta cryst.	*Acta Crystallographica.* International Union of Crystallography. Publisher: Ejnar Munksgaard, Nörregade 6, Copenhagen.
Acta phys. Austriaca	*Acta Physica Austriaca.* Springer-Verlag, Mölkerbastei 5, Vienna I.
Acta phys. Hungar.	*Acta Physica Hungarica.* Magyar Tudományos Akadémia Könyvtára, Akadémia-utca 2, Budapest 5.
Acta phys. Polon.	*Acta Physica Polonica.* Polish Physical Society, ul. Hoza 69, Warsaw.
Acta polytech.	*Acta Polytechnica.* Royal Swedish Academy of Engineering Sciences, Box 5073, Stockholm 5.
Acta Pontif. Acad. Sci.	*Acta Pontificiae Academiae Scientiarum.* Libreria Editrice Vaticana, Città del Vaticano.
Acta tech. Hungar.	*Acta Technica Hungarica.* Magyar Tudományos Akadémia Könyvtára, Akadémia-utca 2, Budapest 5.
Acustica	*Acustica.* S. Hirzel Verlag, Claridenhof, Gotthardstrasse 6, Zürich 2.
Advances in Phys.	*Advances in Physics.* Quarterly Supplement of the *Philosophical Magazine.* Taylor & Francis, Red Lion Court, Fleet Street, London, E.C.4.
Akust. Beihefte	*Akustische Beihefte.* Issued under the auspices of the international acoustics journal *Acustica* as a Supplement. S. Hirzel Verlag, Claridenhof, Gotthardstrasse 6, Zürich 2.
Allis Chalmers elect. Rev.	*Allis Chalmers Electrical Review.* Allis-Chalmers, Milwaukee 1, Wisconsin.
Alta Frequenza	*Alta Frequenza.* Associazione Elettrotecnica Italiana, Via San Paolo 10, Milan.
Amer. Inst. Elect. Engrs Stand.	*American Institute of Electrical Engineers Standard.* 33 West 39th Street, New York 18.
Amer. J. Phys.	*American Journal of Physics.* American Institute of Physics, 57 East 55th Street, New York 22.
Amer. J. Roentgenol.	*American Journal of Roentgenology, Radium Therapy and Nuclear Medicine.* American Roentgen Ray Society. Publisher: Charles C. Thomas, 301–327 East Lawrence Avenue, Springfield, Illinois.
Amer. Stand.	*American Standard.* American Standards Association. 70 East 45th Street, New York 17.

An. Acad. Brasil. Ciênc.	*Anais da Academia Brasileira de Ciências.* Caixa Postal 229, Rio de Janeiro.
An. Inst. Ingen. Chile	*Anales del Instituto de Ingenieros de Chile.* Santiago.
An. Mecan. Elect.	*Anales de Mecanica y Electricidad.* Reina 31, Madrid.
An. Real Soc. Espaň. Fís. Quím.	*Anales de la Real Sociedad Española de Física y Química. Serie A: Física.* Facultad de Ciencias, Seccion de Física, Ciudad Universitaria, Madrid.
Analyt. Chem.	*Analytical Chemistry.* American Chemical Society, 1155 Sixteenth Street N.W., Washington 6, D.C.
Angew. Chem.	*Angewandte Chemie.* Verlag Chemie, Weinheim/Bergstrasse 17(a).
Ann. Acad. Sci. Fennicae	*Annales Academiae Scientiarum Fennicae. Series A I: Mathematica-Physica. Series A II: Chemica. Series A III: Geologica-Geographica.* Snellmaninkatu 9–11, Helsinki.
Ann. Acfas	*Annales de l'Acfas.* Association Canadienne Française pour l'Avancement des Sciences, Université de Montréal, 2900 Boulevard du Mont Royal, Montreal 26.
Ann. Astrophys.	*Annales d'Astrophysique.* Service des Publications du Centre National de la Recherche Scientifique, 45 rue d'Ulm, Paris (V^{e}).
Ann. Franç. Chronom.	*Annales Françaises de Chronométrie.* Observatoire National de Besançon.
Ann. Geofis.	*Annali di Geofisica.* Istituto Nazionale di Geofisica, Città Universitaria, Rome.
Ann. Géophys.	*Annales de Géophysique.* 165 Rue de Sèvres, Paris (XV^{e}).
Ann. Harvard Coll. Obs.	*Annals of the Harvard College Observatory.* Cambridge, Massachusetts.
Ann. Inst. Fourier	*Annales de l'Institut Fourier.* Grenoble.
Ann. Inst. Poincaré	*Annales de l'Institut Henri Poincaré.* 11 Rue Pierre-Curie, Paris (V^{e}).
Ann. Phys. [*Leipzig*]	*Annalen der Physik.* J. A. Barth, Salomonstrasse 18 B, Leipzig, C1.
Ann. Phys. [*Paris*]	*Annales de Physique.* Masson et Cie, 120 Boulevard Saint-Germain, Paris (VI^{e}).
Ann. Radioélect.	*Annales de Radioélectricité.* Compagnies Françaises Associées de T.S.F., 79 Boulevard Haussmann, Paris.
Ann. Soc. Sci. Bruxelles	*Annales de la Société Scientifique de Bruxelles.* 11 Rue des Récollets, Louvain.
Ann. Solar Phys. Obs., Cambridge	*Annals of the Solar Physics Observatory, Cambridge.* Publisher: Cambridge University Press, Bentley House, Euston Road, London, N.W.1.
Ann. Télécomm.	*Annales de Télécommunication.* Centre National d'Etudes des Télécommunications, 24 Rue Bertrand, Paris (VII^{e}).
Ann. Univ. Turku.	*Annales Universitatis Turkuensis. Ser. A: Physico-Mathematica-Biologica.* Turun Yliopiston Kirjasto [Bibliothèque de l'Université], Turku, Finland.
Annu. Fac. Phil. Skoplje	*Annuaire de la Faculté de Philosophie de l'Université de Skoplje. Section des Sciences Naturelles.* Institut de Physique de l'Université d'Etat, Poštanski fah 55, Skoplje (Macédoine), Yugoslavia.
Annu. Proc. Assoc. Socs S. Africa	*Annual Proceedings of the Associated Scientific and Technical Societies of South Africa.* Kelvin House, Marshall and Holland Streets, Johannesburg. [P.O. Box 5907.]
Appl. Math. Ser. Nat. Bur. Stand.	*Applied Mathematics Series, National Bureau of Standards.* U.S. Government Printing Office, Washington 25, D.C.
Appl. Mech. Rev.	*Applied Mechanics Reviews.* American Society of Mechanical Engineers, 29 West 39th St., New York 18.
Appl. sci. Res.	*Applied Scientific Research.* Martinus Nijhoff, The Hague.
Appl. Spectrosc.	*Applied Spectroscopy.* Society for Applied Spectroscopy. Editor: Calco Chemical Division, American Cyanamid Co., Bound Brook, New Jersey.
Applic. and Industr.	*Applications and Industry.* Part 2 of *Transactions of the American Institute of Electrical Engineers.* 33 West 39th Street, New York 18.
Arch. elekt. Übertragung	*Archiv der elektrischen Übertragung.* S. Hirzel Verlag, Birkenwaldstrasse 185, Stuttgart.
Arch. Elektrotech.	*Archiv für Elektrotechnik.* Springer-Verlag, Reichpietschufer 20, Berlin, W.35; Neuenheimer Landstrasse 24, Heidelberg.
Arch. Math. Naturvid.	*Archiv for Mathematik og Naturvidenskab.* Faculty of Mathematics and Science, University of Oslo, Blindern, per Oslo.
Arch. Meteorol.	*Archiv für Meteorologie, Geophysik und Bioklimatologie* (*Serie A und Serie B*). [Abstracted by *Meteorological Abstracts.*]
Arch. Sci. [*Geneva*]	*Archives des Sciences.* Société de Physique et d'Histoire Naturelle de Genève. University of Geneva.
Arch. tech. Messen	*Archiv für technisches Messen.* R. Oldenbourg Verlag, Lotzbeckstr. 2b, Munich.
Ark. Astron.	*Arkiv för Astronomi.* Kungliga Svenska Vetenskapsakademien, Stockholm 50.
Ark. Fys.	*Arkiv för Fysik.* Kungliga Svenska Vetenskapsakademien, Stockholm 50.
Ark. Geofys.	*Arkiv för Geofysik.* Kungliga Svenska Vetenskapsakademien, Stockholm 50.
Ark. Kemi	*Arkiv för Kemi.* Kungliga Svenska Vetenskapsakademien, Stockholm 50.
Ark. Mat.	*Arkiv för Matematik.* Kungliga Svenska Vetenskapsakademien, Stockholm 50.
Ark. Mineral.	*Arkiv för Mineralogi och Geologi.* Kungliga Svenska Vetenskapsakademien, Stockholm 50.
Asea J.	*Asea Journal.* ASEA Electric Ltd., Fulbourne Road, London, E.17; Allmänna Svenska Elektriska AB, Västerås.
Astron. J.	*Astronomical Journal.* American Astronomical Society. Editor: Astronomical Journal, Yale University Observatory, New Haven 11, Connecticut.
Astron. Nachr.	*Astronomische Nachrichten.* Akademie-Verlag, Schiffbauerdamm 19, Berlin, N.W.7.

Astron. News Letter [Harvard]	*Astronomical News Letter.* Harvard College Observatory, Cambridge, Massachusetts.
Astrophys. J.	*Astrophysical Journal.* University of Chicago Press, 5750 Ellis Avenue, Chicago.
Astrophys. Norveg.	*Astrophysica Norvegica.* Faculty of Mathematics and Science, University of Oslo, Blindern, per Oslo.
Atomic Energy Res. Establ. [Harwell] Rep.	*Atomic Energy Research Establishment [Harwell] Report.* H.M. Stationery Office, Kingsway, London, W.C.2.
Atomics [London]	*Atomics.* Leonard Hill Technical Group, Eden House, 9 Eden Street, London, N.W.1.
Atti Accad. Sci. Torino	*Atti dell'Accademia delle Scienze di Torino.* Via Accademia delle Scienze 6; Via Maria Vittoria 3, Turin (101).
Atti Fond. Ronchi	*Atti Fondazione "Giorgio Ronchi."* Via S. Leonardo 79, Firenze-Arcetri.
Audio Engng	*Audio Engineering.* Radio Magazines, 342 Madison Avenue, New York 17.
Austral. J. appl. Sci.	*Australian Journal of Applied Science.* Commonwealth Scientific and Industrial Research Organization, 314 Albert Street, East Melbourne, C.2.
Austral. J. Sci.	*Australian Journal of Science.* Science House, 157 Gloucester Street, Sydney.
Austral. J. sci. Res.	*Australian Journal of Scientific Research. Series A: Physical Sciences.* Commonwealth Scientific and Industrial Research Organization, 314 Albert Street, East Melbourne, C.2.
Automat. Elect. tech. J.	*Automatic Electric Technical Journal.* 1033 West Van Buren Street, Chicago 7.
Automobile Div. Proc. Instn Mech. Engrs	*Automobile Division Proceedings of the Institution of Mechanical Engineers.* Storey's Gate, St. James's Park, London, S.W.1.
Avhandl. Norske VidenskAkad. Oslo	*Avhandlingar utgitt av Det Norske Videnskaps-Akademi i Oslo. I. Matematisk-Naturvidenskaplige Klasse.* Faculty of Mathematics and Science, University of Oslo, Blindern, per Oslo.
B.B.C. Quart.	*B.B.C. Quarterly.* British Broadcasting Corporation, 35 Marylebone High Street, London, W.1.
BT-H Activ.	*BT-H Activities.* British Thomson-Houston Company, Rugby.
BT-H Res. Lab. Publ.	*British Thomson-Houston Research Laboratory Publication.* British Thomson-Houston Company, Rugby.
BT-H tech. Monogr.	*British Thomson-Houston Technical Monograph.* British Thomson-Houston Company, Rugby.
Beama J.	*Beama Journal.* British Electrical and Allied Manufacturers' Association, 36 Kingsway, London, W.C.2.
Bell Lab. Record	*Bell Laboratories Record.* Bell Telephone Laboratories, 463 West Street, New York 14.
Bell Syst. tech. J.	*Bell System Technical Journal.* American Telephone and Telegraph Co., 195 Broadway, New York 7.
Ber. Sächs. Akad. Wiss. Leipzig	*Berichte über die Verhandlungen der Sächsischen Akademie der Wissenschaften zu Leipzig. Mathematisch-naturwissenschaftliche Klasse.* Akademie-Verlag, Schiffbauerdamm 19, Berlin, N.W.7.
Beretn. Michelsens Inst. Vidensk.	*Beretninger Chr. Michelsens Institutt for Videnskap og Åndsfrihet.* Allégaten 70, Bergen.
Biul. Głów. Inst. Elektrotech.	*Biuletyn Głównego Instytuto Elektrotechniki.* [Published as inset in *Przeglad Elektrotechniczny.*] Al. Czackiego 3/5, Warsaw.
Bol. Radiactiv.	*Boletin de Radiactividad.* Instituto Nacional de Geofísica, Rios Rosas 9, Madrid.
Brennstoff-Wärme-Kraft [BWK]	*BWK. Brennstoff-Wärme-Kraft.* Deutscher Ingenieur-Verlag, Prinz-Georg-Strasse 77, Düsseldorf.
Brit. Elect. Authority Utilis. Res. Rep.	*British Electricity Authority. Utilisation Research Report.* British Electricity House, Great Portland Street, London, W.1.
Brit. Elect. Lab. Mem.	*British Electricity Laboratories Memoir.* British Electricity Authority Research Laboratories, Randall's Farm Lane, Kingston Road, Leatherhead.
Brit. J. appl. Phys.	*British Journal of Applied Physics.* Institute of Physics, 47 Belgrave Square, London, S.W.1.
Brit. J. Radiol.	*British Journal of Radiology.* British Institute of Radiology, 32 Welbeck Street, London, W.1.
Brit. Stand.	*British Standard.* British Standards Institution, 24 Victoria Street, London, S.W.1.
Brown Boveri Rev.	*Brown Boveri Review.* British Brown-Boveri, Artillery Mansions, 75 Victoria Street, London, S.W.1.
Brüel & Kjær tech. Rev.	*Brüel & Kjær Technical Review.* Nærum, Denmark.
Bull. Acad. Roy. Belgique Cl. Sci.	*Bulletin de la Classe des Sciences de l'Académie Royale de Belgique.* Palais des Académies, rue Ducale 1, Brussels.
Bull. Amer. Meteorol. Soc.	*Bulletin of the American Meteorological Society.* 3 Joy St, Boston 8, Massachusetts.
Bull. Assoc. Suisse Elect.	*Bulletin de l'Association Suisse des Electriciens.* Seefeldstrasse 301, Zürich 8.
Bull. astron. [Paris]	*Bulletin Astronomique.* Librairie Gauthier-Villars, Quai des Grands-Augustins 55, Paris (vie).
Bull. Calcutta Math. Soc.	*Bulletin of the Calcutta Mathematical Society.* 92 Upper Circular Road, Calcutta 9.
Bull. Cent. Phys. Nucléaire Bruxelles	*Bulletin du Centre de Physique Nucléaire de l'Université Libre de Bruxelles.* 50 Avenue F. D. Roosevelt, Brussels.
Bull. elect. Engng Educ.	*Bulletin of Electrical Engineering Education.* College of Technology, Manchester 1.

Bull. géod. internat.	*Bulletin Géodésique Internationale.* Bureau Central de l'Association Internationale de Géodésie, 19 rue Auber, Paris (IX^{e}).
Bull. Harvard Coll. Obs.	*Bulletin of the Harvard College Observatory.* Cambridge, Massachusetts.
Bull. Inst. Metals	*Bulletin of the Institute of Metals.* [Issued as inset in *Journal of the Institute of Metals.*] 4 Grosvenor Gardens, London, S.W.1.
Bull. internat. Acad. Polon. Sci.	*Bulletin International de l'Academie Polonaise des Sciences et des Lettres.* Rue Sławkonska, Cracow.
Bull. internat. Acad. Tchèque Sci.	*Bulletin International de l'Académie Tchèque des Sciences.* Česká Akademie Věd a Umění, Narodní tř. 3, Prague.
Bull. Internat. Inst. Refrig.	*Bulletin of the International Institute of Refrigeration.* [English Edition.] 177 Boulevard Malesherbes, Paris (XVII^{e}).
Bull. Internat. Rly Congr. Assoc.	*Monthly Bulletin of the International Railway Congress Association* [English edition]. 19 rue du Beau-Site, Brussels.
Bull. math. Biophys.	*Bulletin of Mathematical Biophysics.* University of Chicago Press, 5750 Ellis Avenue, Chicago 37.
Bull. Oerlikon	*Bulletin Oerlikon.* Ateliers de Constructions Oerlikon, Zürich; Oerlikon Ltd., Victoria House, Southampton Row, London, W.C.1.
Bull. Res. Coun. Israel	*Bulletin of the Research Council of Israel.* P.O. Box 607, Jerusalem.
Bull. Sci. Assoc. Ingén. Montefiore [A.I.M.]	*Bulletin Scientifique de l'Association des Ingénieurs Electriciens sortis de l'Institut Electrotechnique Montefiore.* 31 Rue Saint Gilles, Liège.
Bull. Seismol. Soc. Amer.	*Bulletin of the Seismological Society of America.* University of California Press, Berkeley, California.
Bull. Soc. Belge Elect.	*Bulletin de la Société Belge des Electriciens.* 1 Place du Trône, Brussels.
Bull. Soc. Chim. France	*Bulletin de la Société Chimique de France.* Masson et Cie, 120 Boulevard Saint-Germain, Paris (VI^{e}).
Bull. Soc. Franç. Elect.	*Bulletin de la Société Française des Electriciens.* 8–14 Avenue Pierre Larousse, Malakoff (Seine).
Bull. Soc. Franç. Minéral. Crist.	*Bulletin de la Société Française de Minéralogie et de Cristallographie.* Masson et Cie, 120 Boulevard Saint-Germain, Paris (VI^{e}).
Bull. Soc. Roy. Belge Ingén. Industr.	*Bulletin de la Société Royale Belge des Ingénieurs et des Industriels.* 3 Rue Ravenstein, Brussels.
Bull. Soc. Roy. Sci. Liège	*Bulletin de la Société Royale des Sciences de Liège.* L'Université, 7 Place du 20 Août, Liège.
Bull. Tokyo Inst. Technol.	*Bulletin of the Tokyo Institute of Technology, Series A and B.* Oh-Okayama, Meguroku, Tokyo.
Bull. Un. Exploit. Elect. Belgique	*Bulletin de l'Union des Exploitations Electriques en Belgique.* 63 Rue Ducale, Brussels.
Bull. Univ. Illinois Engng Exper. Sta.	*Bulletin of the University of Illinois Engineering Experiment Station.* Urbana, Illinois.
C.R. Acad. Bulg. Sci.	*Comptes Rendus de l'Académie Bulgare des Sciences (Sciences Mathématiques et Naturelles).* Sofia.
C.R. Acad. Sci. [Paris]	*Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences.* Librairie Gauthier-Villars, Quai des Grands-Augustins 55, Paris.
Câbles et Transm.	*Câbles et Transmission.* SOTELEC, 16 rue de la Beaume, Paris (VIII^{e}).
Cahiers de Phys.	*Cahiers de Physique.* Editions Revue d'Optique, 165 Rue de Sèvres; 3 & 5 Boulevard Pasteur, Paris (XV^{e}).
Canad. J. Chem.	*Canadian Journal of Chemistry.* National Research Council of Canada, Ottawa.
Canad. J. Math.	*Canadian Journal of Mathematics.* [*Journal Canadien de Mathématiques.*] University of Toronto, Toronto.
Canad. J. Phys.	*Canadian Journal of Physics.* National Research Council of Canada, Ottawa.
Canad. J. Technol.	*Canadian Journal of Technology.* National Research Council of Canada, Ottawa.
Cathode Press	*Cathode Press.* Machlett Laboratories, Springdale, Connecticut.
Chalmers Tekn. Högsk. Handl.	*Chalmers Tekniska Högskolans Handlingar.* [*Transactions of the Chalmers University of Technology.*] Gothenburg.
Chem. engng News	*Chemical and Engineering News.* American Chemical Society, 1155 Sixteenth St. N.W., Washington 6, D.C.
Chem.-Ingen.-Tech.	*Chemie-Ingenieur-Technik.* Verlag Chemie, Weinheim/Bergstrasse 17(a).
Chem. Rev.	*Chemical Reviews.* Williams & Wilkins Co., Mt Royal and Guilford Avenues, Baltimore 2, Maryland.
Chin. J. Phys.	*Chinese Journal of Physics.* Chinese Physical Society, National Academy of Peiping, 42 Tung Huang Cheng Ken, Peiping.
Cienc. e Invest.	*Ciencia e Investigación.* Avda R. Sáenz Peña 555, Buenos Aires.
Cienc. y Téc.	*Ciencia y Técnica.* Peru 359 (1° piso), Buenos Aires.
Ciencia [México]	*Ciencia.* Apartado Postal 21033, México, D.F.
Circ. Harvard Coll. Obs.	*Circular of the Harvard College Observatory.* Cambridge, Massachusetts.
Circ. Nat. Bur. Stand.	*Circular of the National Bureau of Standards.* U.S. Government Printing Office, Washington 25.
Circ. Union Obs. [Johannesburg]	*Circular of the Union Observatory.* Johannesburg.
Circ. Univ. Illinois Engng Exper. Sta.	*Circular of the University of Illinois Engineering Experiment Station.* Urbana, Illinois.
Cirk. TelegrStyr. Tekn. Byrå [Stockholm]	*Cirkulär från Telegrafstyrelsens Tekniska Byrå.* Stockholm.
Comment. phys.-math. [Helsinki]	*Commentationes Physico-Mathematicae.* Societas Scientiarum Fennicae. Helsinki.
Comment. Pontif. Acad. Sci.	*Commentationes Pontificiae Academiae Scientiarum.* Libreria Editrice Vaticana, Città del Vaticano.
Commun. and Electronics	*Communication and Electronics.* Part 1 of *Transactions of the American Institute of Electrical Engineers*, 33 West 39th Street, New York 18.
Commun. Dublin Inst. Advanced Stud.	*Communications of the Dublin Institute for Advanced Studies.* 64–65 Merrion Square, Dublin.

Commun. Fac. Sci. Ankara Univ.	*Communications de la Faculté des Sciences de l'Université d'Ankara.* [Foreign language edition of *Ankara Universitesi Fen Fakultesi Mecmuasi.*] Ankara.
Commun. News	*Communication News.* Philips Electrical, Century House, Shaftesbury Avenue, London, W.C.2.
Commun. pure appl. Math.	*Communications on Pure and Applied Mathematics.* Interscience Publishers, 215 Fourth Avenue, New York 3; 2a Southampton Row, London, W.C.1.
Commun. Rev.	*Communication Review.* Communication Engineering Pty, 18 Hunter Street, Sydney.
Conf. Internat. Grands Réseaux Elect. [CIGRE]	*Conférence Internationale des Grands Réseaux Electriques.* 112 Boulevard Haussmann, Paris.
Contrib. Dominion Obs., Ottawa	*Contributions from the Dominion Observatory, Ottawa.* Ottawa.
Curr. Sci.	*Current Science.* Current Science Association, Malleswaran P.O., Bangalore 3.
Czech. J. Phys.	*Czechoslovak Journal of Physics.* Central Institute of Physics, Cukrovarnická 10, Praha-Strešovice.
Direct Curr.	*Direct Current.* Garraway Ltd., 11A Kensington Church Street, London, W.8.
Disc. Faraday Soc.	*Discussions of the Faraday Society.* 6 Gray's Inn Square, London, W.C.1. Publisher: Aberdeen University Press, 6 Upper Kirkgate, Aberdeen.
Dokl. Akad. Nauk SSSR	*Doklady Akademii Nauk SSSR.* Cherkasskiĭ per 2, Moscow.
Dtsch. Elektrotech.	*Deutsche Elektrotechnik.* Verlag Technik, Unter den Linden 12, Berlin, N.W.7.
Dyna	*Dyna.* Navarra 1–1°, Bilbao.
E.R.A. [Stockholm]	*ERA.* Föreningen för Elektricitetens Rationella Användning, Drottninggatan 90B [Box 3222] Stockholm 3.
Elect. Commun.	*Electrical Communication.* International Telephone and Telegraph Corporation, 67 Broad Street, New York 4; Connaught House, Aldwych, London, W.C.2.
Elect. Engng	*Electrical Engineering.* American Institute of Electrical Engineers, 33 West 39th Street, New York 18.
Elect. Engr Merch.	*Electrical Engineer and Merchandiser.* Tait Publishing Co. Pty, 349 Collins Street, Melbourne.
Elect. J.	*Electric Journal.* Bouverie House, 154 Fleet Street, London, E.C.4.
Elect. Light Pwr	*Electric Light and Power.* Haywood Publishing Co., 22 East Huron Street, Chicago 11, Illinois.
Elect. Manuf.	*Electrical Manufacturer.* Morley House, 26–30 Holborn Viaduct, London, E.C.1.
Elect. Rev.	*Electrical Review.* Dorset House, Stamford Street, London, S.E.1.
Elect. Times	*Electrical Times.* Sardinia House, Sardinia Street, London, W.C.2.
Elect. Traction Rlys (Internat. Rly Congr. Assoc.)	*Electric Traction on the Railways.* Bulletin of the International Railway Congress Association. [English Edition.] 19 rue du Beau-Site, Brussels.
Elect. Wld	*Electrical World.* McGraw-Hill Publishing Co., 330 West 42nd Street, New York 36; McGraw-Hill House, 95 Farringdon Street, London, E.C.4.
Electrician	Now *Electric Journal* [*Elect. J.*]
Electricien	*L'Electricien.* 92 Rue Bonaparte, Paris (VIe).
Electronic Applic. Bull.	*Electronic Application Bulletin.* N. V. Philips' Gloeilampenfabrieken, Eindhoven.
Electronic Engng	*Electronic Engineering.* 28 Essex Street, London, W.C.2.
Electronica	*Electronica.* Uitgevers Mij Diligentia, Kalverstraat 35, Amsterdam C.
Electronics	*Electronics.* McGraw-Hill Publishing Co., 330 West 42nd Street, New York 36; McGraw-Hill House, 95 Farringdon Street, London, E.C.4.
Electrotechnics	*Electrotechnics.* Indian Institute of Science, Bangalore 3.
Electrotechniek	*Electrotechniek.* Moorman's Periodieke Pers, Zwarteweg 1, The Hague.
Elekt. Bahnen	*Elektrische Bahnen.* R. Oldenbourg, Schliessfach 31, Munich 1.
Elekt. Stantsii	*Elektricheskie Stantsii.* Ministry of Electric Power Stations. GUM, III Korpus, Vetoshnyi per, Moscow.
Elektrichestvo	*Elektrichestvo.* B Cherkasski per, Moscow.
Elektrizitätsverwertung	*Elektrizitätsverwertung—L'Electrique—Electrical Service.* Elektrowirtschaft, Victoriahaus, Bahnhofplatz 9, Zürich 23.
Elektrizitätswirtschaft	*Elektrizitätswirtschaft.* VDEW, Bockenheimer Landstr. 109, Frankfurt am Main.
Elektron [Garmisch]	*Das Elektron in Wissenschaft und Technik.* Elektron-Verlag, Garmisch-Partenkirchen.
Elektrotech. u. Maschinenbau [EuM]	*Elektrotechnik und Maschinenbau.* Springer-Verlag, Mölkerbastei 5, Vienna I.
Elektrotech. Obzor	*Elektrotechnicky Obzor.* Krakovská 8, Prague II.
Elektrotech. Z. [ETZ]	*Elektrotechnische Zeitschrift. Ausgabe A: Zentralblatt für Elektrotechnik. Ausgabe B: Der Elektrotechniker.* Verband Deutscher Elektrotechniker. Brillerstrasse 99, Wuppertal-Elberfeld.
Elektrotechnika	*Elektrotechnika.* Alkotmány-utca 16, Budapest V.
Elektroteh. Vestnik	*Elektrotehniski Vestnik.* Elektroinstitut Universe, Aškerčeva ul. 11, Lubljana, Yugoslavia.
Elektrotek. T.	*Elektroteknisk Tidsskrift.* Norske Elektrisitetsverkers Forening, Rosenborggt 19, Oslo.
Elektroteknikeren	*Elektroteknikeren.* Østbanegade 7, Copenhagen Ø.

Elettrotecnica	*Elettrotecnica.* Associazione Elettrotecnica Italiana, Via S. Paolo 10 Milan.
Elin-Z.	*Elin-Zeitschrift.* Volksgartenstrasse 1–5, Vienna I.
Elliott J.	*Elliott Journal.* Elliott Bros (London), Century Works, Lewisham London, S.E.13.
Endeavour	*Endeavour.* 26 Dover Street, London, W.1.
Energia elett.	*Energia Elettrica.* Via Revere 14, Milan.
Engineer	*Engineer.* 28 Essex Street, London, W.C.2.
Engineering [*London*]	*Engineering.* 35–36 Bedford Street, London, W.C.2.
Engl. Elect. J.	*English Electric Journal.* English Electric Co., Stafford.
Engng Bull. [*Siemens*]	*Engineering Bulletin.* Siemens Brothers, Woolwich, London, S.E.18.
Engng J.	*Engineering Journal.* Engineering Institute of Canada, 2050 Mansfield Street, Montreal.
Engng Rep. Tsing Hua Univ.	*Engineering Reports of National Tsing Hua University.* Peiping, China.
Entwicklungsber. Siemens & Halske	*Entwicklungsberichte der Siemens & Halske Aktiengesellschaft.* Berlin Siemensstadt.
Ericsson Rev.	*Ericsson Review.* L. M. Ericsson, Stockholm 32.
Ericsson Tech.	*Ericsson Technics.* L. M. Ericsson, Stockholm 32.
Experientia	*Experientia.* E. Birkhäuser, Elisabethenstrasse 15, Basle 10.
F & G Rdsch.	*F & G Rundschau.* Felten & Guilleaume Carlswerk, Cologne-Mülheim
Fernmeldetech. Z.	*Fernmeldetechnische Zeitschrift.* Friedr. Vieweg & Sohn, Burgplatz 1 Brunswick 20B.
Forsvarets ForsknInst. Årbok	*Forsvarets Forskningsinstitut Årbok.* Norwegian Defence Research Establishment, Storgaten 33, Oslo.
Fortschr. Radiotech.	*Fortschritte der Radiotechnik. Archiv für radiotechnische Neuerungen.* Franksche Verlagshandlung, Pfizerstr. 5–7, Stuttgart.
Frequenz	*Frequenz.* Fachverlag Schiele & Schön, Boppstrasse 10, Berlin, S.W.29.
Funk u. Ton	*Funk und Ton.* Verlag für Radio-Foto-Kinotechnik, Eichborndamm 141/167, Berlin-Borsigwalde.
Fysisk T.	*Fysisk Tidsskrift.* Selskabet for Naturlærens Udbredelse [Society for the Propagation of Natural Science.] Jul. Gjellerup's Boghandel, Solvgade 87, Copenhagen K.
G.E.C. J.	*G.E.C. Journal.* General Electric Co., Magnet House, Kingsway, London, W.C.2.
G.E.C. Telecomm.	*G.E.C. Telecommunications.* General Electric Co., Telephone, Radio and Television Works, Coventry.
Gaz. Mat. [*Lisbon*]	*Gazeta de Matemática.* Rua Almirante Barroso 20, r/c, Lisbon-N.
Gen. Elect. Rev.	*General Electric Review.* General Electric Co., Schenectady, New York; Crown House, Aldwych, London, W.C.2.
Geofis. pura appl.	*Geofisica Pura e Applicata.* Istituto Geofisico Italiano, Piazza Leonardo da Vinci 12 [Casella Postale 3689], Milan-Ferrovia.
Geofys. Publ.	*Geofysiske Publikationer.* Norske Meteorologiske Institutt, Oslo.
Geophys. Mem. Meteorol. Off. [*London*]	*Geophysical Memoirs. Meteorological Office* [*Air Ministry*]. H.M. Stationery Office, Kingsway, London, W.C.2.
Geophysics	*Geophysics.* Society of Exploration Geophysicists, 1138 E. 37th St. [Box 7248], Tulsa 18, Oklahoma.
Gidrotekh. Stroit.	*Gidrotekhnicheskoe Stroitelstvo.* GUM, III Korpus, Vetoshnyi per., Moscow.
Glasers Ann.	*Glasers Annalen.* Georg Siemens, Nollendorfstr. 28, Berlin W.30.
Guide Russ. Sci. Lit. [*Brookhaven*]	*Guide to Russian Scientific Periodical Literature.* Brookhaven National Laboratory, Upton, Long Island, New York.
Handb. Nat. Bur. Stand.	*Handbook of the National Bureau of Standards.* U.S. Government Printing Office, Washington.
Harvard Coll. Obs. tech. Rep.	*Harvard College Observatory Technical Report.* Cambridge, Massachusetts.
Helv. phys. Acta	*Helvetica Physica Acta.* Schweizerische Physikalische Gesellschaft. Publisher: E. Birkhäuser, Elisabethenstrasse 15, Basle 10.
Houille blanche	*La Houille Blanche.* Rue Paul-Verlaine, Post Box 41, Grenoble (Isère).
I.V.A. [*Stockholm*]	*IVA. Tidskrift för Teknisk-Vetenskaplig Forskning.* IngeniörsVetenskaps-Akademien, Grevturegatan 14, Stockholm 5.
Illum. Engng	*Illuminating Engineering.* 32nd Street and Elm Avenue, Baltimore, Maryland.
Indian east. Engr	*Indian and Eastern Engineer.* P.O. Box 2348, Calcutta; 39 Lombard Street, London, E.C.3.
Indian J. Meteorol. Geophys.	*Indian Journal of Meteorology and Geophysics.* India Meteorological Department, Lodi Road, New Delhi 3.
Indian J. Phys.	*Indian Journal of Physics* and *Proceedings of the Indian Association for the Cultivation of Science.* 2 and 3 Lady Willingdon Road, Calcutta 32.
Industr. engng Chem.	*Industrial and Engineering Chemistry.* American Chemical Society, 1155 Sixteenth Street, N.W., Washington 6, D.C.
Industr. Ital. elettrotec.	*Industria Italiana Elettrotecnica.* Via Donizetti 30, Milan.
Ingegn. Ferroviaria	*Ingegneria Ferroviaria. Rivista dei Trasporti.* Piazza Croce Rossa, Rome.
Ingegnere	*L'Ingegnere.* Associazione Nazionale Ingegneri ed Architetti Italiani, Via F. Civinini 37, Rome.
Ingenieur	*De Ingenieur.* Koninklijk Instituut van Ingenieurs, 23 Prinsessegracht, The Hague.

Ingeniøren	*Ingeniøren.* Dansk Ingeniørforening, 29 Vester Farimagsgade, Copenhagen V.
IngenVetenskAkad. Handl.	*Ingeniörsvetenskapsakademien Handlingar.* Grevturegatan 14, Stockholm 5.
IngenVetenskAkad. Medd.	*Ingeniörsvetenskapsakademien Meddelanden.* Grevturegatan 14, Stockholm 5.
IngenVidensk. Skr.	*Ingeniørvidenskabelige Skrifter.* Akademiet for de Tekniske Videnskaber. Østervoldgade 10, Copenhagen K.
Inst. Petrol. Rev.	*Institute of Petroleum Review.* Manson House, 26 Portland Place, London, W.1.
Instn Elect. Engrs Monogr.	*Institution of Electrical Engineers Monograph.* Institution of Electrical Engineers, Savoy Place, London, W.C.2. [Available separately; republished in *Proceedings, Part IV*; page number will be found in a later abstract.]
Instn Elect. Engrs Paper	*Institution of Electrical Engineers Paper.* Institution of Electrical Engineers, Savoy Place, London, W.C.2. [Available separately in proof form in advance of publication in *Proceedings*; page number in *Proceedings* will be found in a later abstract.]
Instrumentation	*Instrumentation.* Minneapolis-Honeywell Regulator Co., Brown Instruments Division, Wayne and Windrim Avenues 'Philadelphia 44; Honeywell Brown, 1 Wadsworth Road, Perivale, Greenford, Middlesex.
Instruments	*Instruments.* Instruments Publishing Company, 921 Ridge Avenue, Pittsburgh 12, Pennsylvania.
Istanbul Tek. Üniv. Bült.	*Istanbul Teknik Üniversitesi Bülteni.* [*Bulletin of the Technical University of Istanbul.*] Yazi Heyeti Sekreterliğine, Gümüssuyu, Istanbul.
Izv. Akad. Nauk, SSSR, Otdel. tekh. Nauk	*Izvestiya Akademii Nauk, SSSR. Otdelenie Tekhnicheskikh Nauk.* Cherkasski per 2, Moscow.
Izv. Akad. Nauk, SSSR, Ser. fiz.	*Izvestiya Akademii Nauk, SSSR. Seriya Fizicheskaya.* Cherkasski per 2, Moscow.
Izv. Bulg. Akad. Nauk	*Izvestiya Bulgarskata Akademia nà Naukite. Otdelenie za Fiziko-matematicheski i Tekhnicheski Nauki.* Rue 7 Noemvri, Sofia 1.
J. Acoust. Soc. Amer.	*Journal of the Acoustical Society of America.* American Institute of Physics, 57 East 55th Street, New York 22.
J. Amer. Chem. Soc.	*Journal of the American Chemical Society.* 1155 Sixteenth Street N.W., Washington 6, D.C.
J. appl. Mech.	*Journal of Applied Mechanics.* American Society of Mechanical Engineers, 29 West 39th Street, New York 18.
J. appl. Phys.	*Journal of Applied Physics.* American Institute of Physics, 57 East 55th Street, New York 22.
J. atmos. terrest. Phys.	*Journal of Atmospheric and Terrestrial Physics.* Pergamon Press, 2, 3 and 5 Studio Place, Kinnerton Street, London, S.W.1.
J. Brit. Astron. Assoc.	*Journal of the British Astronomical Association.* 303 Bath Road, Hounslow West, Middlesex.
J. Brit. Instn Radio Engrs	*Journal of the British Institution of Radio Engineers.* 9 Bedford Square, London, W.C.1.
J. Brit. Interplan. Soc.	*Journal of the British Interplanetary Society.* 12 Bessborough Gardens, London, S.W.1.
J. chem. Phys.	*Journal of Chemical Physics.* American Institute of Physics, 57 East 55th Street, New York 22.
J. Chem. Soc.	*Journal of the Chemical Society.* Burlington House, London, W.1.
J. Chim. phys.	*Journal de Chimie Physique.* Ecole Nationale Supérieure de Chimie, 11 rue Pierre Curie, Paris (V^{e}).
J. Colloid Sci.	*Journal of Colloid Science.* Academic Press, 125 East 23rd Street, New York 10.
J. Electrochem. Soc.	*Journal of the Electrochemical Society.* 235 West 102nd Street, New York 25.
J. Electrodep. Tech. Soc.	*Journal of the Electrodepositors' Technical Society.* 32 Great Ormond Street, Holborn, London, W.C.1.
J. Fac. Sci. Hokkaidô Univ.	*Journal of the Faculty of Science, Hokkaidô University. Series II (Physics).* Sapporo, Japan.
J. Fac. Sci. Univ. Tokyo	*Journal of the Faculty of Science, University of Tokyo. Section I: Mathematics, Astronomy, Physics, Chemistry.*
J. Franklin Inst.	*Journal of the Franklin Institute.* 20th St. and Benjamin Franklin Parkway, Philadelphia 3, Pennsylvania.
J. geophys. Res.	*Journal of Geophysical Research.* Johns Hopkins Press, Baltimore 18, Maryland.
J. Glaciol.	*Journal of Glaciology.* British Glaciological Society, c/o Royal Geographical Society, Kensington Gore, London, S.W.7.
J. Indian Inst. Sci.	*Journal of the Indian Institute of Science.* Bangalore 3.
J. Inst. Elect. Commun. Engrs Japan	*Journal of the Institute of Electrical Communication Engineers of Japan.* Nagasaki Building, 2–8 Fujimicho, Chiyoda-ku, Tokyo.
J. Inst. Elect. Engrs Japan	*Journal of the Institute of Electrical Engineers of Japan* [Denki-Gakkwai] No. 3, 1-Chome Yurako-Cho, Chiyoda-ku, Tokyo.
J. Inst. Fuel	*Journal of the Institute of Fuel.* 18 Devonshire Street, London, W.1.
J. Inst. Metals	*Journal of the Institute of Metals.* 4 Grosvenor Gardens, London, S.W.1.
J. Inst. Navig.	*Journal of the Institute of Navigation.* 1 Kensington Gore, London, S.W.7.
J. Inst. Petrol.	*Journal of the Institute of Petroleum.* Manson House, 26 Portland Place, London, W.1.
J. Instn Engrs Australia	*Journal of the Institution of Engineers, Australia.* Science House, Gloucester and Essex Streets, Sydney.
J. Iron Steel Inst.	*Journal of the Iron and Steel Institute.* 4 Grosvenor Gardens, London, S.W.1.

J. Jr Instn Engrs	*Journal of the Junior Institution of Engineers.* 39 Victoria Street, London, S.W.1.
J. Math. Phys.	*Journal of Mathematics and Physics.* Massachusetts Institute of Technology, Cambridge 39, Massachusetts.
J. Opt. Soc. Amer.	*Journal of the Optical Society of America.* American Institute of Physics, 57 East 55th Street, New York 22.
J. phys. Chem.	*Journal of Physical Chemistry.* American Chemical Society, 1155 Sixteenth Street N.W., Washington 6, D.C.
J. Phys. Radium	*Journal de Physique et le Radium.* 10 rue Vauquelin, Paris (V^e).
J. Phys. Soc. Japan	*Journal of the Physical Society of Japan.* Department of Physics, Faculty of Science, University of Tokyo, Bunkyo-ku, Tokyo.
J. Rech. Cent. Nat. Rech. Sci.	*Journal des Recherches du Centre National de la Recherche Scientifique.* 13 Quai Anatole-France, Paris (VII^e).
J. Res. Nat. Bur. Stand.	*Journal of Research of the National Bureau of Standards.* U.S. Government Printing Office, Washington 25, D.C.
J. Roy. Astron. Soc. Canada	*Journal of the Royal Astronomical Society of Canada.* 3 Willcocks Street, Toronto.
J. Roy. Soc. Arts	*Journal of the Royal Society of Arts.* 6–8 John Adam Street, London, W.C.2.
J. Roy. Soc. New S. Wales	*Journal and Proceedings of the Royal Society of New South Wales.* Science House, 157 Gloucester Street, Sydney.
J. Roy. Tech. Coll., Glasgow	*Journal of the Royal Technical College, Glasgow.* Glasgow.
J. Sci. Hiroshima Univ.	*Journal of Science of the Hiroshima University. Series A* (*Mathematics, Physics, Chemistry*). Hiroshima, Japan.
J. sci. industr. Res.	*Journal of Scientific and Industrial Research.* Council of Scientific and Industrial Research, Hillside Road, Pusa, Delhi, 5.
J. sci. Instrum.	*Journal of Scientific Instruments.* Institute of Physics, 47 Belgrave Square, London, S.W.1.
J. sci. Res. Banaras Hindu Univ.	*Journal of Scientific Research of the Banaras Hindu University.* P.O.—Banaras Hindu University, India.
J. Sci. Res. Inst. [*Tokyo*]	*Journal of the Scientific Research Institute.* 31 Kamifujimae-cho, Komagome, Bunkyo-ku, Tokyo.
J. Soc. Dyers Colourists	*Journal of the Society of Dyers and Colourists.* 19 Piccadilly, Bradford.
J. Soc. Glass Technol.	*Journal of the Society of Glass Technology.* "Elmfield," Northumberland Road, Sheffield 10.
J. Soc. Motion Picture Televis. Engrs	*Journal of the Society of Motion Picture and Television Engineers.* 40 West 40th Street, New York 18.
J. Tech. Assoc. Malaya	*Journal of the Technical Association of Malaya.* Post Box 664, Singapore.
J. Televis. Soc.	*Journal of the Television Society.* 164 Shaftesbury Avenue, London, W.C.2.
J. Univ. Bombay	*Journal of the University of Bombay.* Fort, Bombay.
J. Washington Acad. Sci.	*Journal of the Washington Academy of Sciences.* U.S. National Museum, Washington 25, D.C.
Japan. J. Astron.	*Japanese Journal of Astronomy.* Science Council of Japan, Ueno Park, Tokyo.
Japan Sci. Rev.	*Japan Science Review.* Publisher: Association for Science Documents Information, c/o Tokyo Institute of Technology, Oh-okayama, Meguro-ku, Tokyo.
Jodrell Bank Ann.	*Jodrell Bank Annals* [*Astronomical Contributions from the University of Manchester, Series I*]. Jodrell Bank Experimental Station, Holmes Chapel, Cheshire.
Joel [*Jordbruk. elekt. Blad*]	*JOEL. Jordbrukarens Elektriska Blad.* Föreningen för Elektricitetens Rationella Användning (FERA), Box 3222, Stockholm 3.
K. Danske Vidensk. Selsk., mat-fys. Medd.	*Kongelige Danske Videnskabernes Selskab, Matematisk-fysiske Meddelelser.* Ny Vestergade 23, Copenhagen 5.
K. Fysiogr. Sällsk. Lund, Förhandl.	*Kungliga Fysiografiska Sällskapets i Lund, Förhandlingar.* Lund.
K. Norske Vidensk. Selsk. Forhandl.	*Kongelige Norske Videnskabers Selskabs Forhandlinger.* F. Bruns Bokhandel, Trondheim.
K. Norske Vidensk. Selsk. Skr.	*Kongelige Norske Videnskabers Selskabs Skrifter.* F. Bruns Bokhandel, Trondheim.
K. Tekn. Högsk. Avhandl.	*Kungliga Tekniska Högskolans Avhandlingar* [*Royal Institute of Technology, Thesis*]. Stockholm.
K. Tekn. Högsk. Handl.	*Kungliga Tekniska Högskolans Handlingar.* [*Transactions of the Royal Institute of Technology.*] Stockholm.
Kraft o. Ljus	*Kraft och Ljus.* Ehrensvärdsvägen 10, Helsinki.
L.S.E. Engng Bull.	*L.S.E. Engineering Bulletin.* Laurence, Scott and Electromotors, Manfield House, Southampton Street, Strand, London, W.C.2.
Lab. Pract.	*Laboratory Practice.* United Trade Press, 24 Bride Lane, Fleet Street, London, E.C.3.
Latv. PSR Zināt. Akad. Vēstis	*Latvijas PSR Zinātnu Akademijas Vēstis.* Biblioteka Akademii Nauk, Ul. Kommunalnaya 4, Riga.
Leafl. Astron. Soc. Pacific	*Leaflet of the Astronomical Society of the Pacific.* 675 Eighteenth Avenue, San Francisco, California.
Light and Ltg	*Light and Lighting.* Illuminating Engineering Society, 32 Victoria Street, London, S.W.1.
Lunds Univ. Årsskr.	*Lunds Universitets Årsskrift, Avd.* 2. Lund.
Luz y Fuerza	*Luz y Fuerza.* Editorial Gabel, General Goded 1, Madrid.
Mag. Concrete Res.	*Magazine of Concrete Research.* Cement and Concrete Association, 52 Grosvenor Gardens, London, S.W.1.

Marconi Instrum.	*Marconi Instrumentation.* Marconi Instruments, St. Albans, Hertfordshire.
Marconi Rev.	*Marconi Review.* Marconi Wireless Telegraph Company, Marconi House, Chelmsford, England.
Marelli	*Marelli.* Ercole Marelli, Corso Venezia 16, Milan.
Maschinenbau u. Wärmewirtsch. [*MuW*]	*Maschinenbau und Wärmewirtschaft, mit Lokomotiv- und Fahrzeugbau.* Springer-Verlag, Mölkerbastei 5, Vienna I.
Math. Tables Aids Comput.	*Mathematical Tables and Other Aids to Computation.* National Academy of Sciences, 2101 Constitution Avenue, Washington, D.C.
Mech. Engng	*Mechanical Engineering.* American Society of Mechanical Engineers, 29 West 39th Street, New York 18.
Meded. K. Vlaamse Acad. Wetensch.	*Mededelingen van de Koninklijke Vlaamse Academie voor Wetenschappen, Letteren en Schone Kunsten van België.* Paleis des Academiën, Hertogelijke Straat 1, Brussels.
Mém. Acad. Polon. Sci.	*Mémoires de l'Académie Polonaise des Sciences et des Lettres. Classe des Sciences Mathématiques et Naturelles.* Cracow.
Mém. Acad. Roy. Belgique Cl. Sci.	*Mémoires de la Classe des Sciences de l'Académie Royale de Belgique.* Palais des Académies, Rue Ducale 1, Brussels.
Mem. Accad. Naz. Lincei	*Atti dell'Accademia Nazionale dei Lincei. Memorie della Classe di Scienze Fisiche, Matematiche e Naturali.* Via della Lungera 10, Rome.
Mem. Fac. Engng Hokkaido Univ.	*Memoirs of the Faculty of Engineering, Hokkaido University.* Hokkaido University, Sapporo, Japan.
Mem. Fac. Engng Kyoto Univ.	*Memoirs of the Faculty of Engineering, Kyoto University.* Kyoto, Japan.
Mem. Fac. Engng Kyushu Univ.	*Memoirs of the Faculty of Engineering, Kyushu University.* Fukuoka, Kyushu, Japan.
Mem. Fac. Sci. Engng Waseda Univ.	*Memoirs of the Faculty of Science and Engineering, Waseda University.* Tokyo.
Mem. Fac. Sci. Kyūsyū Univ.	*Memoirs of the Faculty of Science of Kyūsyū* [*Kyushu*] *University, Series B: Physics.* Hukuoka [Fukuoka], Japan.
Mem. India Meteorol. Dep.	*Memoirs of the India Meteorological Department.* Lodi Road, New Delhi 3.
Mém. Inst. Roy. Météorol. Belgique	*Mémoires. Institut Royal Météorologique de Belgique.* 3 Avenue Circulaire, Uccle III, Belgium.
Mem. Inst. Sci. Industr. Res. Osaka Univ.	*Memoirs of the Institute of Scientific and Industrial Research, Osaka University.* Kitashanada-cho 555, Sakai, Osaka, Japan.
Mem. Manchester Lit. Phil. Soc.	*Memoirs and Proceedings of the Manchester Literary and Philosophical Society.* Portico Library, 57 Mosley Street, Manchester 2.
Mem. Res. Inst. Acoust. Sci. Osaka Univ.	*Memoirs of the Research Institute of Acoustical Science. Osaka National University.* Nagisi, Hirakate-shi, Osaka-fu, Japan.
Mem. Soc. Astron. Ital.	*Memorie della Società Astronomica Italiana.* Via Brera 28, Milan.
Mém. Soc. Roy. Belge Ingén. Industr.	*Mémoires de la Société Royale Belge des Ingénieurs et des Industriels.* 3 Rue Ravenstein, Brussels.
Mém. Soc. Roy. Sci. Liége	*Mémoires de la Société Royale des Sciences de Liége.* L'Université, 7 Place du 20 Août, Liége.
Meteorol. Abstr.	*Meteorological Abstracts and Bibliography.* American Meteorological Society, 3 Joy Street, Boston 8, Massachusetts.
Meteorol. Ann.	*Meteorologiske Annaler.* Norske Meteorologiske Institutt, Oslo.
Meteorol. Rep. Meteorol. Off. [*London*]	*Meteorological Reports. Meteorological Office* [*Air Ministry*]. H.M. Stationery Office, Kingsway, London, W.C.2.
Metropolitan-Vickers Gaz.	*Metropolitan-Vickers Gazette.* Metropolitan-Vickers Electrical Co., Trafford Park, Manchester 17.
Mining elect. mech. Engr	*Mining Electrical and Mechanical Engineer.* Cromwell Buildings, Blackfriars Street, Manchester 3.
Misc. Inst. Roy. Météorol. Belgique	*Miscellanées. Institut Royal Météorologique de Belgique.* 3 Avenue Circulaire, Uccle III, Belgium.
Misc. Publ. Nat. Bur. Stand.	*Miscellaneous Publications of the National Bureau of Standards.* U.S. Government Printing Office, Washington 25, D.C.
Mitt. Inst. Geophys. E.T.H. Zürich	*Mitteilungen aus dem Institut für Geophysik.* Eidgenössische Technische Hochschule, Leonhardstrasse 33, Zürich.
Monogr. Res. Inst. Appl. Elect. Hokkaido Univ.	*Monograph Series of the Research Institute of Applied Electricity.* Hokkaido University, Sapporo, Japan.
Monogr. Roy. Soc. New S. Wales	*Monograph of the Royal Society of New South Wales.* Science House, 157 Gloucester Street, Sydney.
Monthly Bull. Brit. Coal Utilis. Res. Assoc.	*Monthly Bulletin of the British Coal Utilisation Research Association.* Randalls Road, Leatherhead, Surrey.
Monthly Not. Roy. Astron. Soc.	*Monthly Notices of the Royal Astronomical Society.* Burlington House, London, W.1.
Monthly Not. Roy. Astron. Soc., Geophys. Suppl.	*Monthly Notices of the Royal Astronomical Society, Geophysical Supplement.* Burlington House, London, W.1.
Monthly Notes Astron. Soc. S. Africa	*Monthly Notes of the Astronomical Society of South Africa.* Royal Observatory, Cape of Good Hope, South Africa.
Muirhead Tech.	*Muirhead Technique.* Muirhead & Co., Beckenham, Kent.
Mullard tech. Commun.	*Mullard Technical Communications.* Century House, Shaftesbury Avenue, London, W.C.2.
Mullard tech. Rep.	*Mullard Technical Report.* Mullard Electronic Products, Century House, Shaftesbury Avenue, London, W.C.2.
Murex Rev.	*Murex Review.* Murex Ltd., Rainham, Essex.
Nachr. Akad. Wiss. Göttingen	*Nachrichten der Gesellschaft der Wissenschaften zu Göttingen. Mathematisch-physikalische Klasse. IIa: Mathematisch-physikalisch-chemische Abteilung. IIb: Biologisch-physiologisch-chemische Abteilung.* Göttingen.
Nachrichtentechnik	*Nachrichtentechnik.* Verlag Technik, Unter den Linden 12, Berlin, N.W.7.

Nat. Res. Coun. Canada Publ.	*National Research Council of Canada, Publications.* National Research Council of Canada, Ottawa.
Nature [*London*]	*Nature.* Macmillan & Co., St. Martin's Street, London, W.C.2.
Naturwissenschaften	*Die Naturwissenschaften.* Springer-Verlag, Reichpietschufer 20, Berlin-Charlottenburg 2.
Navy Dep., Taylor Model Basin Rep.	*Navy Department, David W. Taylor Model Basin, Report.* Washington 7, D.C.
New York Univ. (*Washington Sq. Coll.*) *Math. Res. Group, Res. Rep.*	*New York University, Washington Square College of Arts and Science, Mathematics Research Group, Research Reports.* Washington Square, New York 3.
New Zealand Engng	*New Zealand Engineering.* 18 Aurora Terrace, Wellington, C 1.
New Zealand J. Sci. Technol.	*New Zealand Journal of Science and Technology. B: General Research Section.* Department of Scientific and Industrial Research, P.O. Box 8018, Wellington.
Non-destr. Test.	*Non-destructive Testing.* American Industrial Radium and X-ray Society, P.O. Box 710, Evanston, Illinois.
Notes appl. Sci. Nat. Phys. Lab.	*Notes on Applied Science. National Physical Laboratory.* H.M. Stationery Office, Kingsway, London, W.C.2.
Nucleonics	*Nucleonics.* McGraw-Hill Publishing Co., 330 W. 42nd Street, New York 18; McGraw-Hill House, Farringdon Street, London, E.C.4.
Nuovo Cimento	*Il Nuovo Cimento.* Società Italiana di Fisica. Istituto di Fisica dell' Università, Via Saldini 50, Milan.
Observatory	*Observatory.* Royal Observatory, Herstmonceux Castle, Hailsham, Sussex.
Occ. Notes Roy. Astron. Soc.	*Occasional Notes of the Royal Astronomical Society.* Burlington House, London, W.1.
Onde élect.	*L'Onde Electrique.* Société des Radioélectriciens, 10 Avenue Pierre-Larousse, Malakoff (Seine).
Optik	*Optik.* Wissenschaftliche Verlagsgesellschaft, Postfach 40, Stuttgart I.
Ossvz. Oss. Astrofis. Arcetri	*Osservazioni e Memorie dell'Osservatorio Astrofisico di Arcetri.* Florence.
Österr. Ingen. Arch.	*Österreichisches Ingenieur Archiv.* Springer-Verlag, Mölkerbastei 5, Vienna I.
Österr. Z. ElektWirtsch. [*ÖZE*]	*Österreichische Zeitschrift für Elektrizitätswirtschaft.* Fachverband der Elektrizitätswerke Österreichs. Publisher: Springer-Verlag, Mölkerbastei 5, Vienna I.
Österr. Z. Telegr.-Teleph.-Funk-Fernsehtech. [*ÖTF*]	*Österreichische Zeitschrift für Telegraphen-, Telephon-, Funk- und Fernsehtechnik.* Organ der Post und Telegraphenverwaltung. Publisher: Springer-Verlag, Mölkerbastei 5, Vienna I.
PTT-Bedrijf	*PTT-Bedrijf.* Hoofdbestuur der Posterijen, Telegrafie en Telefonie. 12 Kortenaerkade, The Hague.
Pakistan J. Sci.	*Pakistan Journal of Science.* Pakistan Association for the Advancement of Science, University Institute of Chemistry, The Mall, Lahore.
Pakistan J. sci. Res.	*Pakistan Journal of Scientific Research.* [Published with *Pakistan Journal of Science.*] Pakistan Association for the Advancement of Science, University Institute of Chemistry, The Mall, Lahore.
Pap. Instn Post Off. Elect. Engrs	*Institution of Post Office Electrical Engineers, Printed Papers.* Alder House, Aldersgate Street, London, E.C.1.
Pap. phys. Oceanogr. Meteorol.	*Papers in Physical Oceanography and Meteorology.* Woods Hole Oceanographic Institution, Woods Hole, Massachusetts.
Period. math.-phys. astron. [*Zagreb*]	*Periodicum Mathematico-physicum et Astronomicum* [*Glasnik Matematičko-fizički i Astronomski*]. Hrvatski Prirodoslovno Društvo [Societas Scientiarum Naturalium Croatica]. Maruličev trg 19, Zagreb.
Phil. Mag.	*Philosophical Magazine.* Taylor & Francis, Red Lion Court, Fleet Street, London, E.C.4.
Phil. Trans.	*Philosophical Transactions of the Royal Society of London. Series A* (*Mathematical and Physical Sciences*). Burlington House, London, W.1.
Philips Res. Rep.	*Philips Research Reports.* Century House, Shaftesbury Avenue, London, W.C.2.; Philips' Gloeilampenfabrieken, Eindhoven.
Philips tech. Rev.	*Philips Technical Review.* Century House, Shaftesbury Avenue, London, W.C.2; Philips' Gloeilampenfabrieken, Eindhoven.
Photoelect. Spectrom. Group Bull. [*Cambridge*]	*Photoelectric Spectrometry Group Bulletin.* Unicam Instruments, Arbury Works, Cambridge.
Photogr. J.	*Photographic Journal.* Section B: Scientific and Technical Photography. Royal Photographic Society of Great Britain, 16 Princes Gate, London, S.W.7.
Phys. Blätt.	*Physikalische Blätter.* Physik-Verlag, Scheffelstr. 1, Mosbach/Baden.
Phys. Rev.	*Physical Review.* American Institute of Physics. 57 East 55th Street, New York 22.
Phys. Today	*Physics Today.* American Institute of Physics, 57 East 55th Street, New York 22.
Physica	*Physica.* The Physica Foundation, Bijlhouwerstraat 6, Utrecht.
Portugal. Math.	*Portugaliae Mathematica.* Rua Serpa Pinto 17, Lisbon.
Portugal. Phys.	*Portugaliae Physica.* Laboratorio de Física, Faculdade de Ciências, Rua da Escola Politécnica, Lisbon.
Post Off. elect. Engrs' J.	*Post Office Electrical Engineers' Journal.* Alder House, Aldersgate Street, London, E.C.1.
Poste e Telecom.	*Poste e Telecomnicazioni.* Istituto Superiore delle Poste e delle Telecomunicazioni, Viale Trastevere 189, Rome.
Powder Metall. Bull.	*Powder Metallurgy Bulletin.* 320 Yonkers Avenue, Yonkers 2, New York.

Proc. Amer. Acad. Arts Sci.	*Proceedings of the American Academy of Arts and Sciences.* 28 Newbury Street, Boston, Massachusetts.
Proc. Amer. Phil. Soc.	*Proceedings of the American Philosophical Society.* Independence Square, Philadelphia 6, Pennsylvania.
Proc. Amer. Pwr Conf.	*Proceedings of the American Power Conference.* Illinois Institute of Technology, Technology Center, 3300 South Federal Street, Chicago 16, Illinois.
Proc. Cambridge Phil. Soc.	*Proceedings of the Cambridge Philosophical Society.* Free School Lane, Cambridge. Publisher: Cambridge University Press, Bentley House, 200 Euston Road, London, N.W.1.
Proc. Egypt. Acad. Sci.	*Proceedings of the Egyptian Academy of Sciences.* "Dar el Hikma," 42 Qasr el Aini Street, Cairo.
Proc. Indian Acad. Sci.	*Proceedings of the Indian Academy of Sciences. Section A.* Hebbal Post, Bangalore 6, South India.
Proc. Inst. Radio Engrs	*Proceedings of the Institute of Radio Engineers.* 1 East 79th Street, New York 21.
Proc. Instn Civil Engrs	*Proceedings of the Institution of Civil Engineers. Part I (General. Ordinary Meetings and Other Selected Papers); Part II (Engineering Divisions. Airport. Maritime. Railway. Road); Part III (Engineering Divisions. Public Health. Structural and Building. Works Construction.)* Great George Street, London, S.W.1.
Proc. Instn Elect. Engrs	*Proceedings of the Institution of Electrical Engineers. Part I (General); Part II (Power Engineering); Part III (Radio and Communication Engineering); Part IV (Institution Monographs).* Savoy Place, London, W.C.2.
Proc. Instn Mech. Engrs	*Proceedings of the Institution of Mechanical Engineers.* Storey's Gate, St. James's Park, London, S.W.1.
Proc. Instn Radio Engrs Australia	*Proceedings of the Institution of Radio Engineers, Australia.* Science House, 157 Gloucester Street, Sydney.
Proc. Iowa Acad. Sci.	*Proceedings of the Iowa Academy of Sciences.* Des Moines, Iowa.
Proc. Japan Acad.	*Proceedings of the Japan Academy.* Ueno Park, Tokyo.
Proc. K. Ned. Akad. Wetensch.	*Proceedings. Koninklijke Nederlandsche Akademie van Wetenschappen. Series B (Physical Sciences).* Trippenhuis, Amsterdam.
Proc. Leeds Phil. Lit. Soc.	*Proceedings of the Leeds Philosophical and Literary Society.* The University, Leeds.
Proc. Nat. Acad. Sci. India	*Proceedings of the National Academy of Sciences, India. Section A.* University Science Buildings, Allahabad.
Proc. Nat. Acad. Sci. U.S.A.	*Proceedings of the National Academy of Sciences of the United States of America.* 2101 Constitution Avenue, Washington 25, D.C.
Proc. Nat. Inst. Sci. India	*Proceedings of the National Institute of Sciences of India.* Mathura Road, New Delhi.
Proc. Phys. Soc. [*London*]	*Proceedings of the Physical Society. Sections A and B.* 1 Lowther Gardens, Prince Consort Road, London, S.W.7.
Proc. Roy. Irish Acad.	*Proceedings of the Royal Irish Academy.* Hodges, Figgis, 6 Dawson Street, Dublin; Williams & Norgate, 36 Great Russell Street, London, W.C.1.
Proc. Roy. Soc.	*Proceedings of the Royal Society of London. Series A (Mathematical and Physical Sciences).* Burlington House, London, W.1.
Proc. Roy. Soc. Edinburgh	*Proceedings of the Royal Society of Edinburgh. Section A (Mathematical and Physical Sciences).* 22–24 George Street, Edinburgh; Publisher: Oliver & Boyd, Tweeddale Court, Edinburgh; 98 Great Russell Street, London, W.C.1.
Proc. Roy. Soc. Victoria	*Proceedings of the Royal Society of Victoria.* Victoria Street, Melbourne, C.1.
Proc. Soc. Exper. Stress Anal.	*Proceedings of the Society for Experimental Stress Analysis.* [Abstracted by *Applied Mechanics Reviews.*]
Proc. Univ. Durham Phil. Soc.	*Proceedings of the University of Durham Philosophical Society.* Durham.
Prof. Notes Meteorol. Off. [*London*]	*Professional Notes. Meteorological Office* [*Air Ministry*]. H.M. Stationery Office, Kingsway, London, W.C.2.
Progr. theor. Phys.	*Progress of Theoretical Physics.* Department of Physics, Kyoto University, Kyoto, Japan.
Prom. Energ.	*Promyshlennaya Energetika.* GUM, III Korpus, Vetoshnyĭ per., Moscow.
Przeglad elektrotech.	*Przeglad Elektrotechniczny.* al. Czackiego 3/5, Warsaw.
Przeglad telekom.	*Przeglad Telekomunikacyjny.* al. Czackiego 3/5, Warsaw.
Pubbl. Ist. Elettroacust. Corbino	*Pubblicazioni dell'Istituto Nazionale di Elettroacustica "O.M. Corbino."* Piazzale delle Scienze 7, Rome.
Pubbl. Ist. Elettrotec. Naz. Ferraris	*Pubblicazioni dell'Istituto Elettrotecnico Nazionale "Galileo Ferraris."* Corso Massimo d'Azeglio, Turin 116.
Publ. Astron. Soc. Japan	*Publications of the Astronomical Society of Japan.* Tokyo Astronomical Observatory, Mitaka, Tokyo.
Publ. Astron. Soc. Pacific	*Publications of the Astronomical Society of the Pacific.* 675 Eighteenth Avenue, San Francisco, California.
Publ. Dominion Astrophys. Obs. Victoria, B.C.	*Publications of the Dominion Astrophysical Observatory, Victoria, British Columbia.* Dominion Observatory, Ottawa.
Publ. Dominion Obs. Ottawa	*Publications of the Dominion Observatory.* Ottawa.
Publ. Internat. Electrotech. Comm.	*Publication of the International Electrotechnical Commission.* 39 Route de Malagnou, Geneva.
Publ. Istanbul Univ. Obs.	*Publications of the Istanbul University Observatory.* [*Istanbul Üniversite Observatuari Yazilari.*] Istanbul.
Publ. Roy. Obs. Edinburgh	*Publications of the Royal Observatory, Edinburgh.* Edinburgh.
Publ. sci. Assoc. Océanogr. Phys.	*Publication Scientifique d'Association d'Océanographie Physique.* [Union Géodésique et Géophysique Internationale.] Prof. H. Mosby, Geofysiske Institutt, Bergen.
Pwr Apparatus and Syst.	*Power Apparatus and Systems.* Part 3 of *Transactions of the American Institute of Electrical Engineers.* 33 West 39th Street, New York 18.

QST	*QST.* American Radio Relay League, 38 LaSalle Road, West Hartford, Connecticut.
Quad. Stud. Not.	*Quaderni di Studi e Notizie.* Società Edison, Giunta Tecnica di Gruppo, Foro Bonaparte 31, Milan.
Quart. appl. Math.	*Quarterly of Applied Mathematics.* Brown University, Providence 12, Rhode Island.
Quart. J. Mech. appl. Math.	*Quarterly Journal of Mechanics and Applied Mathematics.* Oxford University Press, Amen House, London, E.C.4.
Quart. J. Roy. Meteorol. Soc.	*Quarterly Journal of the Royal Meteorological Society.* 49 Cromwell Road, London, S.W.7.
R.C.A. Rev.	*RCA Review.* Radio Corporation of America, RCA Laboratories Division, Princeton, New Jersey.
R.C. Accad. Naz. Lincei	*Atti dell'Accademia Nazionale dei Lincei. Rendiconti della Classe di Scienze Fisiche, Matematiche e Naturali.* Via della Lungera 10, Rome.
R.C. Ist. Super. Sanità	*Rendiconti dell'Istituto Superiore di Sanità.* Fondazione Emanuele Paternò, Viale Regina Margherita 299, Rome.
R.C. Riun. Assoc. Elettrotec. Ital.	*Rendiconti della Riunione Annuale dell'Associazione Elettrotecnica Italiana.* Via S. Paolo 10, Milan.
Radio Commun.	*Radio Communication (FM-TV, The Journal of).* The Publishing House, Great Barrington, Massachusetts.
Radio-Electronic Engng	*Radio-Electronic Engineering.* [Published as a special edition in a limited number of copies of *Radio and Television News.*] Ziff-Davis Publishing Co., 366 Madison Avenue, New York 17.
Radio-Electronics	*Radio-Electronics.* 25 West Broadway, New York 7.
Radio Res. Special Rep. [*London*]	*Radio Research, Special Reports.* Department of Scientific and Industrial Research, Dorland House, 14–16 Regent Street, London, S.W.1.
Radio Televis. News	*Radio and Television News.* Ziff-Davis Publishing Co., 366 Madison Avenue, New York 17.
Radiology	*Radiology.* Radiological Society of North America, 713 E. Genesee Street, Syracuse 2, New York.
Receuil Trav. chim. Pays-Bas	*Receuil des Travaux Chimiques des Pays-Bas.* Nederlandse Chemische Vereniging, Lange Voorhout 5, The Hague.
Rensselaer Polytech. Inst. Bull., Engng Sci. Ser.	*Rensselaer Polytechnic Institute Bulletin, Engineering and Science Series.* Rensselaer Polytechnic Institute, Troy, New York.
Rep. Brit. Elect. Res. Assoc.	*Reports of the British Electrical and Allied Industries Research Association.* Thorncroft Manor, Dorking Road, Leatherhead, Surrey, England.
Rep. Progr. Phys.	*Reports of the Physical Society on Progress in Physics.* 1 Lowther Gardens, Prince Consort Road, London, S.W.7.
Rep. Res. Inst. Elect. Commun. Tôhoku Univ.	*Reports of the Research Institute of Electrical Communication of Tôhoku University.* [A section of *Science Reports of the Research Institutes Tôhoku University, Series B (Technology).*] Tôhoku University, Sendai.
Repr. Univ. Illinois Engng Exper. Sta.	*Reprint Series of the University of Illinois Engineering Experiment Station.* Urbana, Illinois.
Research	*Research.* Butterworths Scientific Publications, 4, 5, 6 Bell Yard, Temple Bar, London, W.C.2.
Rev. Chim. pura appl.	*Revista de Chimica Pura e Applicada.* Laboratorio Ferreira de Silva, Faculdade da Ciencias, Porto.
Rev. Cienc. apl.	*Revista de Ciencia Aplicada.* Alcalá 95, bajo, [Apartado de correos 743], Madrid.
Rev. Elect. Mécan.	*Revue d'Electricité et de Mécanique.* Société Générale de Constructions Electriques et Mécaniques Alsthom. 38 Avenue Kléber, Paris (XVI^{e}).
Rev. Electrotéc.	*Revista Electrotécnica.* Asociacion Argentina de Electrotecnicos, Posadas 1657–59, Buenos Aires.
Rev. Fac. Sci. Univ. Istanbul	*Revue de la Faculté des Sciences de l'Université d'Istanbul* [*Istanbul Universitesi Fen Fakultesi Mecmuasi*]. *Seri A: Matematik-Fizik-Kimya.* Büyük Resit Pasa caddesi, Beyazit-Istanbul.
Rev. gén. Elect.	*Revue Générale d'Electricité.* 12 Place Henri-Bergson, Paris (VIII^{e}).
Rev. Geofis.	*Revista de Geofísica.* Instituto Nacional de Geofísica, Rios Rosas 9, Madrid.
Rev. Jeumont	*Revue Jeumont.* Forges et Ateliers de Construction Electriques de Jeumont, Jeumont (Nord).
Rev. Mexicana Fís.	*Revista Mexicana de Física.* Instituto de Física, Tacubo No. 5, Mexico 1, D.F.
Rev. mod. Phys.	*Reviews of Modern Physics.* American Institute of Physics, 57 East 55th Street, New York 22.
Rev. Obras publ.	*Revista de Obras Publicas.* Alfonso XII, 3-Escuela de Caminos, Madrid.
Rev. Opt.	*Revue d'Optique (Théorique et Instrumentale).* 165 Rue de Sèvres; 3 & 5 Boulevard Pasteur, Paris (XV^{e}).
Rev. RTT	*Revue RTT.* Régie des Télégraphes et Téléphones, 42 Rue des Palais, Brussels III.
Rev. sci. [*Paris*]	*La Revue Scientifique.* 4 rue Pomereu, Paris (XVI^{e}).
Rev. sci. Instrum.	*Review of Scientific Instruments.* American Institute of Physics, 57 East 55th Street, New York 22.
Rev. tech. C.F.T.H.	*Revue Technique des Departements Radio de la Compagnie Française Thomson-Houston.* 4 Rue du Fossé-blanc, Gennevilliers (Seine).
Rev. tech. Luxemb.	*Revue Technique Luxembourgeoise.* L'Association Luxembourgeoise des Ingénieurs et Industriels. 15 Boulevard Roosevelt, Luxembourg.
Rev. Telecom.	*Revista de Telecomunicación.* Consejo Tecnico de Telecomunicación, Apartado 936, Palacio de Comunicaciones, Madrid.
Rev. Univ. Tucumán	*Revista de la Universidad Nacional de Tucumán. Serie A: Matematicas y Física Teorica.* Tucumán, Argentine.
Reyrolle Rev.	*Reyrolle Review.* A. Reyrolle & Co., Hebburn, Co. Durham.

Ricerca sci.	*La Ricerca Scientifica.* Consiglio Nazionale delle Ricerche, Piazzale delle Scienze 7, Rome.
S. African J. Sci.	*South African Journal of Science.* South African Association for the Advancement of Science, P.O. Box 6894, Johannesburg.
S.B. Dtsch. Akad. Wiss. Berlin	*Sitzungsberichte der Deutschen Akademie der Wissenschaften zu Berlin. Klasse für Mathematik und allgemeine Naturwissenschaften.* Unter den Linden 8, Berlin, N.W.7.
S.B. Heidelberg. Akad. Wiss.	*Sitzungsberichte der Heidelberger Akademie der Wissenschaften. (Mathematisch-naturwissenschaftliche Klasse).* Publisher: Springer-Verlag, Neuenheimer Landstrasse 24, Heidelberg.
S.B. Österr. Akad. Wiss.	*Sitzungsberichte der Österreichischen Akademie der Wissenschaften. Abteilung IIa: Mathematik, Astronomie Physik, Meteorologie und Technik.* Publisher: Springer-Verlag, Mölkerbastei 5, Vienna.
Safety Mines Res. Establ. Res. Rep.	*Safety in Mines Research Establishment Research Report.* Ministry of Fuel and Power, Safety in Mines Research Establishment, Portobello Street, Sheffield 1.
Schweiz. Arch. angew. Wiss. Tech.	*Schweizer Archiv für angewandte Wissenschaft und Technik.* Buchdruckerei Vogt-Schild, Solothurn.
Schweiz. Bauztg	*Schweizerische Bauzeitung.* Publisher: W. Jegher & A. Ostertag, Dianastrasse 5 [Postfach 39], Zürich.
Sci. and Culture	*Science and Culture.* Indian Science News Association, 92 Upper Circular Road, Calcutta 9.
Sci. of Light [Tokyo]	*Science of Light.* Institute for Optical Research, Tokyo University of Education, 400 4-chome, Hyakunin-machi, Sinjiku-ku, Tokyo.
Sci. Notes India Meteorol. Dep.	*Scientific Notes of the India Meteorological Department.* Lodi Road, New Delhi 3.
Sci. Pap. Osaka Univ.	*Scientific Papers from the Osaka University.* Nakanoshima, Osaka, Japan.
Sci. Proc. Roy. Dublin Soc.	*Scientific Proceedings of the Royal Dublin Society.* Ballsbridge, Dublin.
Sci. Progr.	*Science Progress.* Edward Arnold, 41 Maddox Street, London, W.1.
Sci. Publ. Hebrew Tech. Coll. Haifa	*Scientific Publications of the Hebrew Technical College.* Haifa.
Sci. Rep. Res. Insts Tôhoku Univ.	*Science Reports of the Research Institutes, Tôhoku University. Series A (Physics, Chemistry and Metallurgy).* Tôhoku University, Sendai, Japan.
Sci. Rep. Tôhoku Univ.	*Science Reports of the Tôhoku University. First series (Physics, Chemistry, Astronomy).* Faculty of Science, Tôhoku University, Sendai.
Science	*Science.* American Association for the Advancement of Science, 1515 Massachusetts Avenue N.W., Washington 5, D.C.
Scientia [Asso]	*Scientia.* 4 Via Roncaglia, Asso, Como.
Scientia [Valparaiso]	*Scientia.* Universidad Tecnica Federico Santa Maria, Casilla 110-V, Valparaiso.
Siemens Austria tech. Ber.	*Siemens Austria Technische Berichte.* Siemens & Halske, Apostelgasse 12, Vienna III.
Siemens-Z.	*Siemens-Zeitschrift.* Siemens-Schuckertwerke, Sieboldstrasse 5, Erlangen.
Simon Stevin	*Simon Stevin.* Erven P. Noordhoff, Oude Boteringestraat 12, Groningen.
Skr. Norske VidenskAkad. Oslo	*Skrifter utgitt av det Norske Videnskaps-Akademi i Oslo. I. Matematisk-Naturvidenskaplige Klasse.* Faculty of Mathematics and Science, University of Oslo, Blindern, per Oslo.
Sky and Telescope	*Sky and Telescope.* Sky Publishing Co., Harvard College Observatory, Cambridge 38, Massachusetts.
Slaboproudy Obzor	*Slaboproudy Obzor.* Krakovská 8, Prague II.
Smit Meded.	*Smit Mededelingen.* Willem Smit & Co.'s Transformatorenfabriek, Nijmegen.
Stockholms Obs. Ann.	*Stockholms Observatoriums Annaler.* Kungliga Vetenskapsakademiens Bibliotek, Stockholm 50.
Strowger J.	*Strowger Journal.* Automatic Telephone and Electric Co., Strowger Works, Liverpool 7.
Students' quart J. Instn Elect. Engrs	*Students' Quarterly Journal of The Institution of Electrical Engineers.* Savoy Place, London, W.C.2.
Sulzer tech. Rev.	*Sulzer Technical Review.* Sulzer Bros., 31 Bedford Square, London, W.C.1.
Svenska Elverksfören. Handl.	*Svenska Elverksföreningens Handlingar.* Drottninggatan 90B, Stockholm.
Svenska VattenkrFören. Publ.	*Svenska Vattenkraftföreningens Publikationer.* Norrlandsgatan 16, Stockholm.
Svenska VattenkrFören. Publ. Medd.	*Svenska Vattenkraftföreningens Publikationer. Meddelande.* Norrlandsgatan 16, Stockholm.
Swedish State Pwr Board Publ.	*Swedish State Power Board Publications.* Kungliga Vattenfallsstyrelsen, Karduansmakareg. 8, Stockholm C.
Sylvania Technol.	*Sylvania Technologist.* Sylvania Electric Products, 40–22 Lawrence Street, Flushing, New York.
T. Ljuskultur	*Tidskrift för Ljuskultur.* Svenska Föreningen för Ljuskultur. Sveavägen 28–30, Stockholm.
T. Ned. Radiogenoot.	*Tijdschrift van het Nederlandsch Radiogenootschap.* Fr. v. Mierisstraat 61, Amsterdam-Z.
Tech. Hausmitt. Nordwestdtsch. Rdfunks	*Technische Hausmitteilungen des Nordwestdeutschen Rundfunks.* Funkhaus Hamburg, Rothenbaumchaussee 132–134, Hamburg 13.
Tech. Mitt. PTT	*Technische Mitteilungen PTT.* Schweizerische Post-, Telegraphen- und Telephonverwaltung, Speichergasse 6, Bern.
Tech. mod.	*La Technique Moderne.* 92 Rue Bonaparte, Paris (VIe).
Tech. Rep. Engng Res. Inst. Kyoto Univ.	*Technical Reports of the Engineering Research Institute of Kyoto University.* Kyoto, Japan.

Technik	*Technik.* Verlag Technik, Unter den Linden 12, Berlin, N.W.7.
Technol. Rep. Osaka Univ.	*Technology Reports of the Osaka University.* Faculty of Engineering, Osaka University, Higashinoda, Osaka, Japan.
Technol. Rep. Tôhoku Univ.	*Technology Reports of the Tôhoku University.* Tôhoku University, Sendai, Japan.
Tecn. Ital.	*Tecnica Italiana.* Via Beccaria 6, Trieste.
Técnica [Lisbon]	*Técnica.* Instituto Superior Técnico, Av. Rovisco Pais, Lisbon-N.
Tekh. Khron.	*Tekhnika Khronika.* Technical Chamber of Greece, 4 Kolokotroni St., Athens.
Tekn. Fören. Finland Förhandl.	*Tekniska Föreningens i Finland Förhandlingar.* Svenska Teaterhuset, Helsinki.
Tekn. Medd. TelegrStyr. [Oslo]	*Tekniske Meddelelser fra Telegrafstyret.* Direction Générale des Télécommunications de Norvège, Oslo.
Tekn. Skr.	*Tekniske Skrifter.* Norske Ingeniørforening, Kronprinsengate 17, Oslo 9.
Tekn. T.	*Teknisk Tidskrift.* Svenska Teknologföreningen, Box 16368, Stockholm; Publication address: Box 841, Stockholm.
Tekn. Ukeblad	*Teknisk Ukeblad.* Norske Ingeniørforening, Kronprinsengate 17, Oslo 9.
Tele [Stockholm]	*Tele. Meddelanden från Kungliga Telegrafstyrelsen.* Stockholm.
Telecomm. J. Australia	*Telecommunication Journal of Australia.* Postal Electrical Society of Victoria, G.P.O. Box 4050, Melbourne.
Telecommunications [Jabalpur]	*Telecommunications.* Indian Posts and Telegraphs Department, Ministry of Communications. Additional Chief Engineer, Posts and Telegraphs, Jabalpur (M.P.), India.
Telecomunicazioni	*Telecomunicazioni.* [Published with *Rassegna Poste e Telecomunicazioni.*] Viale Trastevere 189, Rome.
Telefunken Ztg	*Telefunken Zeitung.* Telefunken Gesellschaft, Mehringdamm 32–34, Berlin, S.W.61.
Telegr. en Telef.	*Telegraaf en Telefoon.* Vereniging van Hoger Personeel der PTT, J. W. Frisolaan 36[b], Breda.
Teleteknik	*Teleteknik.* Post. og Telegrafvæsenet, Valkendorfsgade 9[1], Copenhagen.
Tellus	*Tellus.* Svenska Geofysiska Föreningen, Fridhemsgatan 9, Stockholm 12.
Texas J. Sci.	*Texas Journal of Science.* Texas Academy of Science, San Marcos, Texas.
Tôhoku math. J.	*Tôhoku Mathematical Journal.* Mathematical Institute, Tôhoku University, Sendai, Japan.
Trans Amer. Geophys. Un.	*Transactions of the American Geophysical Union.* Administration Building, Carnegie Institution of Washington, D.C., 1530 P Street Northwest, Washington 5, D.C.
Trans Amer. Inst. Elect. Engrs	*Transactions of the American Institute of Electrical Engineers.* 33 West 39th Street, New York 18.
Trans Amer. Phil. Soc.	*Transactions of the American Philosophical Society.* Independence Square, Philadelphia.
Trans Amer. Soc. Mech. Engrs	*Transactions of the American Society of Mechanical Engineers.* 29 West 39th Street, New York 18.
Trans Danish Acad. Tech. Sci.	*Transactions of the Danish Academy of Technical Sciences.* Øster Voldgade 10, Copenhagen.
Trans Faraday Soc.	*Transactions of the Faraday Society.* 6 Gray's Inn Square, London, W.C.1. Publisher: Aberdeen University Press, 6 Upper Kirkgate, Aberdeen.
Trans Illum. Engng Soc.	*Transactions of the Illuminating Engineering Society.* 32 Victoria Street, London, S.W.1.
Trans Inst. Marine Engrs	*Transactions of the Institute of Marine Engineers.* 85 Minories, London, E.C.3.
Trans Instn Engrs Shipbld. Scotland	*Transactions of the Institution of Engineers and Shipbuilders in Scotland.* Elmbank Crescent, Glasgow, C.2.
Trans Instn Naval Archit.	*Transactions of the Institution of Naval Architects.* 10 Upper Belgrave Street, London, S.W.1.
Trans Instn Rubber Industr.	*Transactions of the Institution of the Rubber Industry.* 12 Whitehall, London, S.W.1.
Trans N.-E. Coast Instn Engrs Shipbld.	*Transactions of the North-East Coast Institution of Engineers and Shipbuilders.* Bolbeck Hall, Newcastle upon Tyne 1.
Trans Roy. Soc. Canada	*Transactions of the Royal Society of Canada.* National Research Council, Ottawa.
Trans Roy. Soc. Edinburgh	*Transactions of the Royal Society of Edinburgh.* 22–24 George Street, Edinburgh. Publisher: Oliver & Boyd, Tweeddale Court, Edinburgh; 98 Great Russell Street, London, W.C.1.
Trans Roy. Soc. S. Africa	*Transactions of the Royal Society of South Africa.* University of Cape Town, Rondebosch.
Trans S. African Inst. Elect. Engrs	*Transactions of the South African Institute of Electrical Engineers.* Kelvin House, Marshall and Holland Streets [P.O. Box 5907], Johannesburg.
U.R.S.I. Inform. Bull.	*U.R.S.I. Information Bulletin.* Union Radio Scientifique Internationale. 42 Rue des Minimes, Brussels.
U.R.S.I. Proc. Gen. Assembl.	*U.R.S.I. Proceedings of the General Assembly.* Union Radio Scientifique Internationale, 42 Rue des Minimes, Brussels.
U.R.S.I. Special Rep.	*U.R.S.I. Special Report.* Union Radio Scientifique Internationale, 42 Rue des Minimes, Brussels.
Univ. Bergen Årbok	*Universitet i Bergen. Årbok. Naturvitenskapelig Rekke.* Fysisk Institutt, Bergen.
Univ. Microfilms	*University Microfilms.* 313 North 1st Street, Ann Arbor, Michigan.
VDE-Fachber.	*VDE-Fachberichte.* Verband Deutscher Elektrotechniker. Publisher: VDE-Verlag, Brillerstrasse 99, Wuppertal-Elberfeld.

Vacuum	*Vacuum.* W. Edwards and Co., Worsley Bridge Road, Lower Sydenham, London, S.E.26.
Verhandl. K. Vlaamse Acad. Wetensch.	*Verhandelingen van de Koninklijke Vlaamse Academie voor Wetenschappen, Letteren en Schone Kunsten van België.* Paleis der Academiën, Brussels.
Veröff. Geod. Inst. Potsdam	*Veröffentlichungen des Geodätischen Institutes in Potsdam. Deutsche Akademie der Wissenschaften zu Berlin.* Berlin.
Vestnik Elektroprom.	*Vestnik Elektropromyshlennosti.* Krasnaya Pl., Moscow.
Vide	*Le Vide.* Société Française des Ingénieurs Techniciens du Vide, 44 Rue de Rennes, Paris (VIe).
Water Pwr	*Water Power.* Tothill Press, 33 Tothill Street, London, S.W.1.
Westinghouse Engr	*Westinghouse Engineer.* 401 Liberty Avenue [P.O. Box 2278], Pittsburgh 30, Pennsylvania.
Wireless Engr	*Wireless Engineer.* Dorset House, Stamford Street, London, S.E.1.
Wireless Wld	*Wireless World.* Dorset House, Stamford Street, London, S.E.1.
Wld Pwr Conf.	*General Reports and Papers read before the World Power Conference.* Secretary of the International Executive Council, 201–2 Grand Buildings, Trafalgar Square, London, W.C.2.
Yale sci. Mag.	*Yale Scientific Magazine.* 244–A Yale Station, New Haven, Connecticut.
Z. angew. Math. Phys.	*Zeitschrift für angewandte Mathematik und Physik.* Verlag Birkhäuser, Elisabethenstrasse 15, Basle 10.
Z. angew. Phys.	*Zeitschrift für angewandte Physik.* Springer-Verlag, Reichpietschufer 20, Berlin, W.35.
Z. Astrophys.	*Zeitschrift für Astrophysik.* Springer-Verlag, Reichpietschufer 20, Berlin, W.35; Neuenheimer Landstrasse 24, Heidelberg.
Z. Meteorol.	*Zeitschrift für Meteorologie.* [Abstracted by *Meteorological Abstracts.*]
Z. Naturforsch.	*Zeitschrift für Naturforschung.* Mathildenstrasse 29, Tübingen.
Z. Österr. Ingen.-Archit.-Vereins	*Zeitschrift des Österreichischen Ingenieur- und Architekten-Vereins.* Eschenbachgasse 9, Vienna I.
Z. Phys.	*Zeitschrift für Physik.* Springer-Verlag, Reichpietschufer 20, Berlin, W.35.
Z. phys. Chem.	*Zeitschrift für physikalische Chemie.* Akademische Verlagsgesellschaft. Geest & Portig K.-G., Sternwartenstrasse 8, Leipzig.
Z. Verein. Dtsch. Ingen. [VDI]	*Zeitschrift des Vereines Deutscher Ingenieure.* Deutscher Ingenieur-Verlag, Prinz-Georg Strasse 77/79, Düsseldorf.
Z. wiss. Mikr.	*Zeitschrift für wissenschaftliche Mikroskopie und für mikroskopische Technik.* S. Hirzel Verlag, Birkenwaldstrasse 185, Stuttgart N.
Z. wiss. Photogr.	*Zeitschrift für wissenschaftliche Photographie, Photophysik und Photochemie.* J. A. Barth, Salomonstrasse 18B, Leipzig C1.
Zh. eksper. teor. Fiz.	*Zhurnal Eksperimentalnoĭ i Teoreticheskoi Fiziki.* Akademiya Nauk SSSR, Moscow.
Zh. fiz. Khim.	*Zhurnal Fizicheskoi Khimiĭ.* Cherkasski per 2, Moscow.
Zh. obshch. Khim.	*Zhurnal Obshchei Khimiĭ.* Cherkasski per 2, Moscow.
Zh. tekh. Fiz.	*Zhurnal Tekhnicheskoĭ Fiziki.* Akademiya Nauk SSSR, Moscow.

ABSTRACTING JOURNALS SUPPLEMENT

Abstracts signed with the following names are reproduced from other abstracting journals by the kind permission of the organizations concerned, to whom grateful acknowledgment is made.

Applied Mechanics Reviews	American Society of Mechanical Engineers, 29 West 39th St., New York 18. Editorial Office: Midwest Research Institute, 4049 Pennsylvania, Kansas City 2, Missouri.
Astronomical News Letter	Harvard College Observatory, Cambridge, Massachusetts.
British Abstracts	Bureau of Abstracts, Colquhoun House, Broadwick St., London, W.1.
British Society of Rheology	*Bulletin of the British Society of Rheology.* c/o Department of Scientific and Industrial Research, Mechanical Engineering Research Organization (Lubrication Division), Thorntonhall, nr. Glasgow.
Brookhaven Guide to Russian Literature	*Guide to Russian Scientific Periodical Literature.* Technical Information Division, Brookhaven National Laboratory, Upton, Long Island, New York.
Building Science Abstracts	Department of Scientific and Industrial Research, Building Research Station, Bucknall's Lane, Garston, nr. Watford, Hertfordshire, England.
Coal Utilisation Research Association	*Monthly Bulletin of The British Coal Utilisation Research Association.* Randalls Road, Leatherhead, Surrey, England.
Dissertation Abstracts	University Microfilms, 313 North 1st Street, Ann Arbor, Michigan.
Electrical Research Association	British Electrical and Allied Industries Research Association. Information Bureau, Thorncroft Manor, Dorking Road, Leatherhead, Surrey, England.
Fuel Abstracts	Fuel Research Station, Blackwall Lane, East Greenwich, London, S.E.10.
Index Aeronauticus	Ministry of Supply, Millbank, London, S.W.1.
Internat. Inst. Refrigeration	*Bulletin of the International Institute of Refrigeration.* Institut International du Froid, 177 Boulevard Malesherbes, Paris (XVII^{e}).
Mathematical Reviews	American Mathematical Society, 80 Waterman St., Providence 6, Rhode Island.
Mathematical Tables and other Aids	*Mathematical Tables and Other Aids to Computation.* National Academy of Sciences, 2101 Constitution Avenue, Washington, D.C.
Metallurgical Abstracts	*Journal of the Institute of Metals.* 4 Grosvenor Gardens, London, S.W.1.
Meteorological Abstracts	*Meteorological Abstracts and Bibliography.* American Meteorological Society, 3 Joy Street, Boston 8, Massachusetts. Editorial Office: P.O. Box 1736, Washington 13, D.C.
Metropolitan-Vickers	*Metropolitan-Vickers Technical News Bulletin.* Research Department, Metropolitan-Vickers Electrical Co., Trafford Park, Manchester, England.
Nuclear Science Abstracts	Technical Information Service, U.S. Atomic Energy Commission, P.O. Box 62, Oak Ridge, Tennessee.
Photographic Abstracts	Royal Photographic Society, 16 Princes Gate, London, S.W.7.
Railway Engineering Abstracts	The Institution of Civil Engineers, Great George Street, London, S.W.1.
Rubber Abstracts	Research Association of British Rubber Manufacturers. 105–7 Lansdowne Road, Croydon, Surrey, England.
Scientific Instrument Research Assoc.	*Bulletin of the British Scientific Instrument Research Association.* Information Dept., "Sira," Southill, Elmstead Woods, Chislehurst, Kent, England.

Science Abstracts endeavours to give a comprehensive record of published work in physics and electrical engineering; but there must inevitably be, from time to time, subjects of interest to individual physicists or electrical engineers which fall outside the normal range. For these subjects, reliance must be placed on other abstracting journals; and *Science Abstracts*, while trying to ensure an adequate "overlap," endeavours as far as possible to avoid direct duplication of the work of other well-established English-language abstracting journals covering a clearly defined subject field. In addition to those named above, the following may be brought to the readers' attention:

Aeronautical Reviews (Institute of Aeronautical Sciences, New York).
Bibliography of Seismology (Dominion Observatory, Ottawa).
Biological Abstracts (Philadelphia).
Chemical Abstracts (American Chemical Society, Columbus, Ohio).
Engineering Index (New York).
Geophysical Abstracts (U.S. Dept. of the Interior, Washington, D.C.).
Journal of Glaciology (British Glaciological Society, London).
Journal of the Iron and Steel Institute (London).
Journal of the Royal Microscopical Society (London).
Journal of the Society of Glass Technology (Sheffield).
Mineralogical Abstracts (Mineralogical Society, London).
Road Abstracts (Department of Scientific and Industrial Research, London).
Structure Reports (International Union of Crystallography).
Transactions of the American Geophysical Union (Washington, D.C.).
Transactions of the Institute of Welding (London).

A comprehensive list is given in "Abstracting and Indexing Services of Physics Interest," by Dwight E. Gray and Robert S. Bray (*American Journal of Physics*, **18**, 274–99 (*May*, 1950)); this list covers many foreign journals, and also many journals of electrical interest. It is obtainable from the Office of Technical Services, U.S. Department of Commerce, Washington 25, D.C. (OTS Serial No.: PB 99951). British abstracting journals of all subjects are listed in "A List of Periodicals and Bulletins containing Abstracts published in Great Britain" (2nd Ed., 1950), issued by the Royal Society and published by the Cambridge University Press.

MATHEMATICS 51

513.76

. Dynamical study of groups of transformations. . M. THARRATS VIDAL. *An. Real Soc. Españ. Fis. Quim.*, **48(A)**, 17–26 (*Jan.–Feb.*, 1952) *In Spanish.*

The continuous deformation of a physical system is discussed in terms of one-parameter groups of transformations of 3-space, metrical geometry appearing as a sub-group of projective transformations. The object of the investigation is to isolate aspects of a deformation that are independent of metrical properties. [For application to thermal dilatation, see Abstr. 8687–8 (1951).] R. A. NEWING

517.6

2. On a variant integral associated with the wave equation. F. H. VAN DEN DUNGEN. *C.R. Acad. Sci. Paris*] **235,** 532–3 (*Sept.* 8, 1952) *In French.*

From the wave equation for u, a differential equation is obtained for $V(T) = \iint_S u dS$, S being the surface $t = T$. The resulting relations provide useful checks on results of numerical integrations.

R. H. DALITZ

517.9 : 533.6.01

3. A solution of the telegraph equation with application to two-dimensional supersonic shear flow. C.-C. CHANG AND J. WERNER. *J. Math. Phys.*, **31,** 91–101 (*July*, 1952).

A solution of the telegraph equation, $a\partial^2 u/\partial t^2 + 2b\partial u/\partial t + cu = \partial^2 u/\partial x^2$, in which a, b and c are constants, and which satisfies the boundary conditions $(u_t)_{t=0} = f(x)$ for $0 \leqslant x \leqslant 1$ and $u = u_t = u_x = 0$ for $x - (1/\sqrt{a})t < 0$ is sought. The boundary conditions determine an unique solution for $t \geqslant 0$, $x - (1/\sqrt{a})t \leqslant 1$, and are typical of the problem of supersonic flow over a two-dimensional body of specified profile. Differentiating the telegraph equation and changing the dependent variable in accordance with $u_t = \exp(-bt/a)u'_t$, the equation transforms to $A\partial^2 u'_t/\partial x^2 - \partial^2 u'_t/\partial t^2 + B^2 u'_t = 0$ where $A = 1/a$, $B^2 = (b^2 - ac)/a^2$ and in which the first partial derivative of u'_t does not appear. A solution of this equation is obtained by Riemann's method along lines used by du Bois Reymond and by Picard (see Webster's Partial Differential Equations of Mathematical Physics, 1950). Application of the equation to the case of supersonic shear flow is discussed, an expression being derived for various possible velocity profiles and for the pressure distribution on a parabolic arc aerofoil. J. S. G. THOMAS

517.942.922 : 539.501

A property of Bessel functions and its application to the theory of two rheometers. *See Abstr.* 495

519.2 : 621.311.15

4. Tables of binomial probability distribution to six decimal places. *Pwr Apparatus Syst., No.* 1, 597–620 (*Aug.*, 1952).

The tables were prepared for use in calculating reserve requirements in electric power systems.

519.241.1 : 518.5 : 621.317.79

5. A device for computing correlation functions. A. E. HASTINGS AND J. E. MEADE. *Rev. sci. Instrum.*, **23,** 347–9 (*July*, 1952).

The correlator described does not use discrete pairs of points but continuously delays the time function $f(t)$ to obtain $f(t + \tau)$ and hence their product. The function is recorded as an amplitude modulation directly on magnetic tape. The method is given for computing cross- and auto-correlation functions. The variation in sensitivity of magnetic recording along the tape is noted; this and other disadvantages are discussed. Several examples of its use are given.

A. V. BREHME (R)

ASTRONOMY . ASTROPHYSICS . GEODESY 52

522.21 : 535.81

The use of heat deformation to yield a parabolic surface. *See Abstr.* 172

522.615

6. Application to astronomy of an ideal photon receiver. A. LALLEMAND AND M. DUCHESNE. *C.R. Acad. Sci.* [*Paris*] **235,** 503–5 (*Sept.* 1, 1952) *In French.*

By the use of a special camera, incorporating modified television apparatus for the recording of electronic images in place of the usual photographic emulsion, short-exposure records of celestial objects, normally requiring long exposure times, are possible. Examples are given of stellar and planetary electron images, compared with the corresponding photographic records. Exposure time ratio electronic/photographic is *c.* 1 : 50. It is claimed that the electron images show better contrast and resolution than conventional photographic methods, neither background fog nor granularity being evident. D. R. BARBER

523.162

7. Comparison of the law of variation of interstellar absorption with wavelength in three different regions of the Galaxy. L. DIVAN. *C.R. Acad. Sci.* [*Paris*] **235,** 410–11 (*Aug.* 11, 1952) *In French.*

The three regions lie in Perseus, Cygnus and the neighbourhood of the M 17 nebulosity in Sagittarius. A pair of stars of similar spectral types, one reddened, the other normal (primed), is chosen in each region, and the optical density $A_\lambda = \log I_\lambda/I'_\lambda$ is found as $f(\lambda)$ for each region, correction being made for differences in the extent of the Balmer discontinuities in the two stars. On the assumption that the absorption

coefficient of the absorbing matter is the same in all three regions, ratios of masses of matter in the line of sight are found: m(Perseus)/m(Cygnus) = 0·26, m(Sagittarius)/m(Cygnus) = 1·50. M. W. OVENDEN

523.165

8. A preliminary survey of 1420 Mc/s line emission from galactic hydrogen. W. N. CHRISTIANSEN AND J. V. HINDMAN. *Austral. J. sci. Res. A*, **5**, 437–55 (*Sept.*, 1952).

A preliminary survey of 1420 Mc/s hydrogen-line emission has been made over 270° of galactic longitude extending through the galactic centre and anticentre. The radiation source is in the form of a band of varying intensity along the galactic equator. The maximum brightness temperature is about 100°K, in the direction of the galactic anticentre. Measurements of line-profile show considerable variation, with a minimum width of 0·12 Mc/s. Double lines are evident between galactic longitudes 170 and 240° and it is suggested that these may originate in major structural features of the Galaxy. The change in the peak brightness of the line along the galactic equator may result from line broadening due to galactic rotation. On the other hand it may reveal the existence of highly emitting regions. The latter interpretation is supported by the agreement in position of the bright areas for both the line emission and the continuous-spectrum galactic emission. A.

523.165

9. The positions of six discrete sources of cosmic radio radiation. B. Y. MILLS. *Austral. J. sci. Res.*, **5**, 456–63 (*Sept.*, 1952).

See also Abstr. 6994 (1952). The positions of six discrete sources of cosmic radio radiation have been measured accurately. The tentative identifications of three of the sources with nebulae made by Bolton, Stanley and Slee [Abstr. 58, 79 (1949)] appear to be confirmed. It is also found that two of the sources have measurable angular sizes (about ½°). A.

523.51 : 521.042

10. The abundances of the elements. H. C. UREY. *Phys. Rev.*, **88**, 248–53 (*Oct.* 15, 1952).

The cosmic abundances of the elements were estimated by Goldschmidt (1937) from a study of terrestrial and meteoritic abundances and a comparison of these with Russell's data on the sun. More recently Brown has prepared a table weighting the proportions of the iron and silicate phases according to an estimated proportion of these phases in the earth. The writer has recently proposed that the chondritic meteorites themselves may represent an average sample, and has shown that this assumption is consistent with the density of the moon, which on the basis of his recent discussion in regard to the origin of the solar system should also be approximately a sample of non-volatile materials. A table of abundances is prepared assuming that these meteorites do represent such a mean sample. This table does not differ markedly from Goldschmidt's, but is distinctly different from Brown's, both because of a different weighting of the phases in meteorites and because of a different choice of data from the literature. Iron is much less abundant than estimated by Brown and somewhat less abundant than Goldschmidt's estimate. There is some indication for markedly low abundances of Se and Te and Br and I, which may indicate some escape of these elements during the formation of the meteorites. Hg is low, almost certainly because of its loss as a volatile substance during the formation of the meteorites. A.

523.77 : 551.508.9

Infra-red solar spectroscopy in a high-altitude aircraft. *See Abstr.* 559

523.87

11. Spectrophotometric measures of stellar radiation; application to two white dwarfs. J. BERGER, D. CHALONGE, L. DIVAN AND A.-M. FRINGANT. *C.R. Acad. Sci.* [*Paris*] **235**, 348–50 (*Aug.* 4, 1950) *In French.*

The surface temperature of an early-type star can be found from the energy-wavelength curve defined by the depths of the Balmer lines. The radius of β Aur. deduced from this temperature is in agreement with that found by other methods. The method is applied to the white dwarfs 40 Eri B and Wolf 1346, radii of 0·014 and 0·016 (solar units) respectively being found. M. W. OVENDEN

526.

12. Measurement of the acceleration due to gravity at the Pavillon de Breteuil. C. VOLET. *C.R. Acad. Sci.* [*Paris*] **235**, 442–4 (*Aug.* 11, 1952) *In French.*

By timing the free fall of Invar and bronze rules in air at a pressure of about 1 mm Hg against a quartz crystal frequency standard the value of gravity at Sevres, Point A, has been determined as 980.91 cm/sec², 24 mgal less than that deduced on the Potsdam system. The millimetre graduations on the rules are photographed between 20 and 25 times during the fall and are compared with a photographic record on the same film of the oscillations of the quartz crystal. Times can be measured to 0·3 μs and positions to 1·5 μ. Systematic errors due to magnetic fields and the viscosity of the residual air are discussed. A. H. COOK

526.7

13. Gravity observations in a borehole. R. L. GILBERT. Letter in *Nature* [*London*] **170**, 424–(*Sept.* 6, 1952).

A vibrating string gravimeter, similar to one previously described [Abstr. 4441 (1949)], has been used to measure the variation of gravity in a borehole in the Eakring oilfield at depths between 178 ft and 1226 ft. The probable error of a single observation is about 0·7 mgal. The densities of the rocks penetrated have been calculated from the variation of gravity and agree well with values found from laboratory measurements on chippings from the drilling of the borehole.

A. H. COO

529.77 : 621.317.3

14. The estimation of absolute frequency in 1950–5 H. M. SMITH. *Proc. Instn Elect. Engrs, IV*, **99** 273–8 (*Dec.*, 1952) [*Monogr. No.* 39].

For abstract see Abstr. 5510 (1952).

PHYSICS 53

53.081

5. Discussion of units and dimensions in physics. T. WORRELL; C. H. PAGE. Letters in *Amer. J. Phys.*, **20**, 456–7 (*Oct.*, 1952).

Worrell discusses Page's article [Abstr. 1428 (1952)]. He elaborates on the mistreatment of $F = ma$, points out that Page's method of conversion of units is similar to that used by Worthing [*Amer. J. Phys.*, **8**, 59 (1940)], and states that Page seems to miss the fundamental point of distinction, a philosophical one, his lengthy discussion of whether the 3-dimensional system, *lmt*, is sufficient. Page briefly replies to this last point. S. WEINTROUB

53.087.9 : 537.542 : 531.791

6. A logarithmic counting-rate recorder. D. SHAW AND R. N. WELTMANN. *Rev. sci. Instrum.*, **23**, 828–31 (*Oct.*, 1952). A counting-rate recorder is described which in conjunction with a commercial scaler and associated circuits will plot directly points that are proportional to the logarithm of the time for a predetermined number of counts. The record of the logarithm of the counting rate on a linear scale is obtained from the angle of rotation of a cylinder by means of a logarithmic spiral cut helically around the cylinder, where the angle of rotation corresponds to the time interval. Instrument errors are shown to be less than 1%.

FUNDAMENTALS 530.1

530.12

7. On the approximate solutions of the unified field theory of Einstein and Schrödinger. M. IKEDA. Letter in *Progr. theor. Phys.*, **7**, 127–8 (*Jan.*, 1952).

The results obtained are equivalent to Udeschini's 1st approx. [Abstr. 3312 (1951)]. R. A. NEWING

530.12

8. Equations of fit for spherical distributions. A. C. VAIDYA. Letter in *Curr. Sci.*, **21**, 96 (*April*, 1952).

Boundary conditions are discussed, and it is stated that $\partial\beta/\partial r$ must be continuous, but that the behaviour of the other 1st derivatives of α, β, γ [Abstr. 8650 (1952)] will depend on the particular gravitational situation considered. R. A. NEWING

530.12

9. On the integration of the cosmological equations. P. JORDAN. *Z. Phys.*, **132**, *No.* 5, 655–8 (1952) *In German.*

The author's equations possess a particular integral corresponding to a linear expansion. In order to allow for possible small departures from the linear law, an approximation is obtained for a more general solution of the equations, and the general properties of such solutions are discussed. R. A. NEWING

530.12

10. The role of solid connections in general relativity. T. DE DONDER. *C.R. Acad. Sci.* [*Paris*] **235**, 47–8 (*Aug.* 4, 1952) *In French.*

The invariance of ds^2 under general transformations involves identities satisfied by certain density functions [Abstr. 3006 (1947)]. These, combined with a variational principle and the use of Lagrange multipliers, give the author's gravitational equations. R. A. NEWING

530.12 : 531.31

21. Impulse and mass in relativistic mechanics. F. A. FUERTES. *Univ. Nac. Tucuman Publ., No.* 466, 15 *pp.* (1949) *In Spanish.*

Dependence of mass on velocity, conservation of energy and proportionality between mass and energy are deduced from conservation of impulse. L. PINCHERLE

530.12 : 538.3

22. A simplified form of the relativistic electromagnetic equations. N. W. TAYLOR. *Austral. J. sci. Res. A*, **5**, 423–9 (*Sept.*, 1952).

It is shown how Maxwell's electromagnetic equations in general relativity may be expressed in the form of a single four-vector density equation, in which the field tensor has only three distinct complex components. The number of equations is reduced, but all the usual classical formulae may be obtained by separating the real and imaginary parts. A.

530.145

23. On the concept of the free field. S. HORI. Letter in *Progr. theor. Phys.*, **6**, 903–4 (*Sept.–Oct.*, 1951) *In Esperanto.*

Several conjectures on the quantum field theory of isolated charged particles, based on the principle that a free field should describe particles together with their self fields. R. H. DALITZ

530.145

24. The intrinsic parity of elementary particles. G. C. WICK, A. S. WIGHTMAN AND E. P. WIGNER. *Phys. Rev.*, **88**, 101–5 (*Oct.* 1, 1952).

The limitations to the concept of parity of quantum-mechanical states and, in particular, of intrinsic parity of elementary particles are discussed. These limitations are shown to follow from "superselection rules," i.e. from restrictions on the nature and scope of possible measurements. The existence of such superselection rules is proved for the case of spinor fields; it is also conjectured that a superselection rule operates between states of different total charge. A.

530.145

25. A variational method for radiationless transitions. B. H. BRANSDEN AND A. DALGARNO. Letter in *Phys. Rev.*, **88**, 148 (*Oct.* 1, 1952).

The application of the variational methods of Hulthen [Abstr. 492 (1945)] and Kohn [Abstr. 1511 (1949)] to unstable states (e.g. to the phenomenon of auto-ionization) is described. R. H. DALITZ

530.145 : 539.11

26. Quantum theory of matter. J. C. SLATER. *London, McGraw-Hill* (1951) 528 *pp.*

In this book, the last of a series which are intended to form together "a fairly complete treatment, on the intermediate level of difficulty, of most of theoretical physics with the exception of nuclear theory," the quantum theory is developed starting

from the fundamentals and leading through to the applications to the properties of matter. The chapter headings are: de Broglie waves and wave mechanics; Schrödinger's equation; average values and matrices; perturbations and the action of radiation; the hydrogen atom; the central field model for atomic structure; multiplet structure; the hydrogen molecule; interatomic and intermolecular forces; the metallic state; mechanical, chemical and thermal properties of matter; electrical conductivity; the nature of dielectrics; magnetism. Problems are set at the end of each chapter, and more advanced topics are dealt with in a set of 22 appendices. E. H. SONDHEIMER

530.145

27. On the energy-momentum tensor of Bopp-type non-local fields. Y. Ôno. Letter in *Progr. theor. Phys.*, **6**, 898–9 (*Sept.–Oct.*, 1951).

The energy-momentum tensor for a field theory with Lagrangian density of form $L(x) = \int \phi(x)\varepsilon(x - x')\phi(x')dx'$ is obtained by varying the metrical tensor and is given explicitly for a modified e.m. field theory and for a spinor field theory. R. H. DALITZ

530.145

28. Divergences arising from nuclear forces. T. Nakano and K. Nishijima. Letter in *Progr. theor. Phys.*, **6**, 1024–5 (*Nov.–Dec.*, 1951).

The 4th-order nucleon-nucleon interaction energy is formally investigated for psc. mesons with pv. coupling—the divergences found may not be renormalized away. R. H. DALITZ

530.145

29. Conservation laws for fields of zero rest mass. I. J. A. McLennan, Jr and P. Havas. Letter in *Phys. Rev.*, **87**, 898 (*Sept.* 1, 1952).

For all field equations describing zero rest mass particles and included in Garding's discussion [Abstr. 1630 (1945)], the Bessel–Hagen conservation laws (1921) are shown to be satisfied, implying the invariance of these equations under the conformal group. R. H. DALITZ

530.145

30. Conservation laws for fields of zero rest mass. II. P. Havas. Letter in *Phys. Rev.*, **87**, 898–9 (*Sept.* 1, 1952).

The Bessel–Hagen conservation laws shown in Pt I (preceding abstract) to hold for equations describing fields with zero rest mass do not all hold for the extended system of field and particle in interaction.

R. H. DALITZ

530.145

31. Some consequences of invariance under charge conjugation. L. Wolfenstein and D. G. Ravenhall. *Phys. Rev.*, **88**, 279–82 (*Oct.* 15, 1952).

The charge conjugation operator, which transforms charged fields to their charge-conjugate fields and reverses the sign of the electromagnetic field, is explicitly constructed. States of zero net charge are eigenstates of this operator; the eigenvalues are $(-1)^n$ for states of n photons and $(+1)$ and (-1) for the singlet and triplet S states of positronium, respectively. The effect of charge conjugation on neutral boson fields is also discussed. Physical consequences of the invariance of field theory under this transformation include: 1. For usual interactions a spin-zero particle (including the singlet S state of positronium) cannot decay into three photons, although this decay is shown to be allowed by angular momentum and parity considerations. 2. The $m = 1$ and $m = -1$ levels of triplet positronium cannot be split by a magnetic field.

530.14

32. Vacuum polarisation by spin one particles. J. McConnell. Letter in *Progr. theor. Phys.*, **7**, 421–4 (*April*, 1952).

The calculation of the vac. pol. produced by spin 1 particles coupled to the e.m. field, leading to divergent integrals whose elimination was discussed earlier [Abstr. 4084 (1951)], is given in some detail, in view of the criticisms of Umezawa and Kamefuchi [Abstr. 7938 (1952)]. R. H. DALITZ

530.14

33. β-Matrix formalism as $\varkappa \to 0$. D. C. Peaslee. Letter in *Progr. theor. Phys.*, **6**, 639–41 (*July–Aug.* 1951).

If the equation of motion $(\Box^2 - \kappa^2)\psi = 0$ of a vector field ψ is taken to pass continuously to the limit as $\kappa \to 0$, the subsidiary condition $\partial_\mu A_\mu = 0$, necessary in electrodynamics, is shown to be automatically imposed by the original equations of motion (where $A_\mu = (1 - \beta_\mu^2)(\Sigma\beta_\lambda^2 - 2)\psi/\sqrt{(\kappa)}$ finally the e.m. potential). For the spin-0 β-representation the limit $\kappa \to 0$ is completely continuous.

R. H. DALITZ

530.14

34. On the rôle of longitudinal and scalar photons. T. Kimura and Y. Miyachi. Letter in *Progr. theor. Phys.*, **7**, 419–21 (*April*, 1952).

The canonical transformation which removes the discrepancy between the electron-proton e^2-potential obtained by a covariant treatment of the e.m. field and by a non-covariant treatment in which the Coulomb potential is separated off, is shown to remove corresponding terms of the e^4-potential at the same time. R. H. DALITZ

530.14

35. Contributions to a non-linear electrodynamics. I. K. Bechert. *Ann. Phys.* [*Leipzig*] **10**, *No.* 8, 430–4 (1952) *In German.*

Develops in detail the author's non-linear electrodynamics [Abstr. 73 (1951)]. Deduces the conservation theorem for the stress tensor (the Lorentz equation of motion being a special case), from which the energy and momentum properties are derived. The initial value problem is shown to be properly put, and the sense in which the theory is gauge invariant is discussed. The classical theory is expressed in Hamiltonian form and the quantum formalism is developed, the commutation relations being deduced and shown invariant. Charge conservation is found equivalent to rest-mass conservation.

R. H. DALITZ

530.14

36. On the interaction of cohesive field. K. Sawada. Letter in *Progr. theor. Phys.*, **6**, 626–7 (*July–Aug.* 1951).

A coupling $f(\bar{\psi}\Psi + \bar{\Psi}\psi)\phi$ between proton, "heavy" proton (mass M) and cohesive meson, together with the proton-e.m. coupling, gives (in 2nd order)

e proton self-energy for suitable f, the correct
's defect corresponding to reasonable choice of
whilst the proton-proton force is modified only in
r e^4. R. H. DALITZ

530.145

Note on some type of interaction. K. SAWADA.
er in *Progr. theor. Phys.*, **6**, 637–8 (*July–Aug.*,
1).

field interaction Lagrangian $\{g\psi\eta O\Psi\phi + \text{com-}$
conjugate$\}$ $(\eta = \gamma_1\gamma_3)$ is shown equivalent to
nteraction $\{f\psi^*\gamma_4\gamma_5 O\Psi\phi + \text{c.c.}\}$. R. H. DALITZ

530.145

Non-adiabatic treatment of the relativistic two-
y problem. M. M. LÉVY. *Phys. Rev.*, **88**, 72–82
t. 1, 1952).

he method of Tamm and Dancoff, for the non-
abatic treatment of the relativistic interaction of
nucleons, is generalized in order to include
leon pair creation and higher order effects in the
hange of mesons. This generalized form of the
nm–Dancoff method is shown to give results
ch are equivalent to those obtained from the
tivistic equation of Bethe and Salpeter. A detailed
dy is made of two limiting cases: (*a*) no pair of
leons is created in the intermediate states, but an
itrary number of mesons can be present at the
e time; (*b*) the maximum number of mesons
sent at a given time is one, but the number of
rs is unrestricted. The two methods are applied
he calculation of the lowest order correction to the
lar meson interaction of two nucleons. It is shown
t the exact correction, which is of the second order
he nucleon velocities, can only be obtained through
inclusion of the fourth- and sixth-order interaction
cesses involving, in the corresponding Feynman
grams, the crossing of the meson lines. A.

530.145

Wave equations in de Sitter space. K. GOTO.
ter in *Progr. theor. Phys.*, **6**, 1013–14 (*Nov.–Dec.*,
1).

he five-dimensional spinor analysis previously
veloped [Abstr. 6256 (1950)] is applied to the case
a hyper-sphere immersed in flat 5-space.
R. A. NEWING

530.145

On the spinor form of the physical magnitudes
nected with particles of spin ½. J. WINOGRADZKI.
R. Acad. Sci. [*Paris*] **235**, 463–5 (*Aug.* 18, 1952).

he general spinor form of the mean densities of
ysical quantities corresponding to operators acting
y on the spin is obtained. The five classical
ysical quantities are shown to be determined by
tain symmetry conditions. R. H. DALITZ

530.145

On eight families of operators associated with
ervables of spin ½ particles. J. WINOGRADZKI.
R. Acad. Sci. [*Paris*] **235**, 505–7 (*Sept.* 1, 1952) *In*
nch.

he operators which act only on the spin variables
m eight families with two real parameters.
initely many sets of five physical quantities exist
ose operators form a hypercomplex number
tem and which form a convenient basis for decom-
sition of physical quantities. R. H. DALITZ

530.145

42. On the relations between the mean value densities of the physical quantities connected with spin ½ particles. J. WINOGRADZKI. *C.R. Acad. Sci.* [*Paris*] **235**, 533–5 (*Sept.* 8, 1952) *In French.*

The mean densities of irreducible physical quantities whose corres. operators act only in spin space are shown connected by two independent quadratic relations, which include the Pauli-Kofink relations as special case. R. H. DALITZ

530.145

43. On the introduction of the ideas of pilot-wave and double solution in the theory of the Dirac electron. L. DE BROGLIE. *C.R. Acad. Sci.* [*Paris*] **235**, 557–60 (*Sept.* 15, 1952) *In French.*

It is shown how the causal interpretation of wave mechanics developed by the author (1927) might be extended to relativistic electron theory. R. H. DALITZ

530.145

44. On the physical interpretation of solutions of the Dirac equation for a free particle. S. M. NEAMTAN. *Amer. J. Phys.*, **20**, 450–1 (*Oct.*, 1952).

The usual choice of an orthogonal set of four plane-wave solutions of the free-particle Dirac equation does not lend itself readily to direct and complete physical interpretation except in low energy approximation. A different choice of solutions can be made which yields a direct physical interpretation at all energies. Besides the separation of positive and negative energy states there is a further separation of states for which the spin is respectively parallel or antiparallel to the direction of the momentum vector. A.

530.145

45. Generalized Furry's theorem for closed loops. I–II. K. NISHIJIMA. Letters in *Progr. theor. Phys.*, **6**, 614–15 (*July–Aug.*); 1027–8 (*Nov.–Dec.*, 1951).

For an interaction containing Dirac matrices and isotopic spin operators, a theorem is proved concerning cancellation of related closed loop graphs, which reduces to Furry's theorem in the case of electrodynamics. In symmetrical psc. meson theory, all odd closed nucleon loops cancel. R. H. DALITZ

530.145

46. Meson current around the nucleon. Y. TAKAHASHI. Letter in *Progr. theor. Phys.*, **6**, 624–6 (*July–Aug.*, 1951).

The matrix element for a scalar meson current in which 1 nucleon and no meson are present in the infinite past and future is examined with respect to the τ-dependence. It is concluded that the meson current has the same magnitude and opposite sign for neutrons and protons independently of coupling strength and meson type. W. J. SWIATECKI

530.145

47. On the exchange current. Y. ATAKA. Letter in *Progr. theor. Phys.*, **6**, 627–8 (*July–Aug.*, 1951).

The exchange magnetic moment operator is calculated, to 2nd order in the coupling constant, for nucleons coupled to a psc. meson field with psc. coupling. R. H. DALITZ

530.145

48. On the nuclear forces and the ground state of deuteron. M. Taketani, S. Ônuma and S. Koide. Letter in *Progr. theor. Phys.*, **6**, 635–8 (*July–Aug.*, 1951).

It is considered whether a potential agreeing with a semi-classical meson potential for $r > r_0$ and which is represented by a square well for $r < r_0$, can account for the low energy n–p and deuteron data. For symmetrical psc. theory, crude agreement is obtainable, whereas, for vector theory, the quadrupole moment is always too small. R. H. DALITZ

530.145

49. Meson theory of nuclear forces. M. Taketani, S. Machida and S. Ônuma. Letter in *Progr. theor. Phys.*, **6**, 638–9 (*July–Aug.*, 1951).

The 4th-order static nucleon-nucleon potentials are obtained for a symmetrical psc. meson theory with psc. and pv. coupling, and it is pointed out that, with a suitable cut-off procedure (hard core favoured), these potentials have those features needed to give a fair account of the low energy n–p data. R. H. DALITZ

530.145

50. On the fourth-order nuclear potential. S. Machida, S. Ônuma and M. Taketani. Letter in *Progr. theor. Phys.*, **6**, 904–5 (*Sept.–Oct.*, 1951).

The ps.scalar meson potential with ps.vector coupling taken to 4th order is found to be compatible with the deuteron ground state and low-energy n–p scattering-data, but saturation requirements are not fulfilled. W. J. SWIATECKI

530.145

51. S-matrix and nucleon isobar. S. Kamefuchi, H. Nakai and R. Kawabe. Letter in *Progr. theor. Phys.*, **6**, 891–3 (*Sept.–Oct.*, 1951).

Using the g^2 approximation to κ for meson-nucleon scattering in sc. meson theory, the poles of the corresponding approximate S-matrix $(1 - i\pi\kappa)/(1 + i\pi\kappa)$ are discussed as a possible indication of the presence of nucleon isobars. R. H. DALITZ

530.145

52. On the adiabatic nuclear potential. II. K. Nishijima. *Progr. theor. Phys.*, **6**, 911–24 (*Nov.–Dec.*, 1951).

From the results of Pt I [Abstr. 7968 (1952)] the 4th-order adiabatic potential is obtained, explicitly for sc. and psc. meson theories, and its physical interpretation considered. R. H. DALITZ

530.145

53. Group theoretical aspects in S-matrix theory. D. Ito, H. Tanaka, Y. Watanabe and M. Yamazaki. Letter in *Progr. theor. Phys.*, **7**, 128–30 (*Jan.*, 1952).

Investigates the types of diagram contained in the nth order approximation S_n of the Feynman–Dyson S-matrix and the number of terms belonging to each diagram, and expresses S_n as a sum of contributions from each type of diagram. R. H. DALITZ

530.145

54. Nuclear forces in pseudoscalar meson theory. K. Nakabayasi and I. Sato. Letter in *Phys. Rev.*, **88**, 144 (*Oct.* 1, 1952).

Perturbation calculation up to 4th order in ps.scalar and ps.vector coupling constants taking account of nucleon recoil in intermediate states. The potential is central and strongly repulsive at small distances and contains a charge-exchange part even for charge-symmetric theory. W. J. SWIATECKI

530.145

55. Equivalent potentials. R. Jost and W. Kohn. *Phys. Rev.*, **88**, 382–5 (*Oct.* 15, 1952).

An explicit construction is described for the entire class of potentials leading, for a particular angular momentum, to the same phase shift and energy spectrum as a given central potential. A similar procedure is applied to potentials with purely discrete spectra. A.

530.145.6

56. On the velocity operator in quantum mechanics. T. Nishiyama. Letter in *Progr. theor. Phys.*, **7**, 417–18 (*April*, 1952).

It is shown how simpler expressions for the velocity operator in quantum mechanics can be written than if the classical definition is followed. T. C. TOYE

530.162

57. Information in quantum measurements. H. J. Groenewold. *Proc. K. Ned. Akad. Wetensch. B*, **55**, 219–27 (*May–June*, 1952).

The stochastic relations between the results of a series of successive quantum measuring acts constitute a Markoff chain. The significant statements of quantum mechanics can be expressed in terms of conditional probabilities between different elements of this chain. More indirect conceptions of quantum mechanics as e.g. quantum state also have a conditional meaning. The statistical disorder or uncertainty of a quantum system can be measured in terms of entropy or information. It is increased by intervention of a measuring instrument and can be decreased by gaining information out of the measurement. The choice of the elements of the Markoff chain which will be compared with each other is the "subjective" feature of the description, the statistical relations between the chosen elements form the "objective" feature. A.

530.162

58. The Brownian motion of coupled systems. P. G. Hodge, Jr. *J. Math. Phys.*, **31**, 120–30 (*July*, 1952).

Expressions are derived for the mean square displacement of an "instrument" surrounded by a fluid. The term "instrument" referring to any mechanical system. T. C. TOYE

MECHANICAL MEASUREMENTS 531.7

531.717 : 534.321.9

59. An ultrasonic phase lag method for measuring the thickness of rubber. P. Hatfield. *Brit. J. Appl. Phys.*, **3**, 326–8 (*Oct.*, 1952).

A method for measuring the thickness when only one surface is available is described. This method, working at 50 kc/s frequency, was chosen because at this frequency ultrasonic absorption losses in rubber are low. The method was developed to measure thickness of rubber in the range 5–20 mm with an accuracy of ± 1 mm. A.

MECHANICS OF FLUIDS 532

532.137

. On the oscillating cylinder viscometer. I. A. K. Ibrahim and A. M. Kabiel. Letter in *appl. Phys.*, **23**, 1190 (*Oct.*, 1952).

A further discussion of the authors' theory of the drodynamics of the oscillating coaxial cylinder scosimeter [see Abstr. 7066 (1952)]. T. C. TOYE

532.517

. Remarks on "Stability of the laminar parabolic ow." T. Tatsumi. Letter in *Phys. Rev.*, **87**, 1127 ept. 15, 1952).

Pekeris [Abstr. 2735 (1948)] has deduced that minar parabolic flow is stable for any value of eynolds's number, R, a result which contradicts rlier results [Heisenberg (1924), Lin (1945), nomas, Abstr. 6317 (1952)]. It is now shown athematically that this contradiction is attributable incompleteness of the approximation used by ekeris. Results, identical with those obtained by ekeris, so far as the principal terms are concerned re obtained and indicate stability of the disturbance, ut the approximation used is inadequate for valuating the real eigenvalue since it neglects the pid variation of the superposed disturbance, and f the imaginary part of a factor, K', which usually lays an important rôle when instability is concerned. ekeris's prediction of the "second class" of perturbaon is in error owing to the use of an inadequate symptotic expansion for $\alpha R \to \infty$. This "second lass" of perturbation is only an alternative expression or the ordinary class perturbation. J. S. G. THOMAS

532.527 : 534.222.2

2. Experimental study of the formation of a vortex ing at the open end of a cylindrical shock tube. . K. Elder, Jr and N. de Haas. *J. appl. Phys.*, **23**, 065–9 (*Oct.*, 1952).

Schlieren spark snapshots spaced at electronically ontrolled intervals of several hundredths of a millieond show the emergence of the shock wave and the ormation of the vortex ring at the end of a cylindrical hock tube, open to the atmosphere. The axial ositions of the vortex ring and shock front are lotted as a function of time for the first millisecond, n which time the vortex forms and is accelerated to bout three-quarters of the theoretical particle elocity of the mass flow following the initial plane hock. The diameter of the vortex ring increases nonlinearly with time and distance. A.

CAPILLARITY 532.6

532.614

53. Contact angles and boundary energies of a low energy solid. F. M. Fowkes and W. M. Sawyer. Letter in *J. chem. Phys.*, **20**, 1650 (*Oct.*, 1952).

γ_{SV} and γ_{SL} have been determined for a series of fractions obtained by vacuum distillation of a perfluorinated lubricating oil, which varied from liquids to brittle low-energy solids. Good agreement was found between the observed contact angles and those calculated from the theoretical relation $\gamma_{SV} - \gamma_{SL} = \gamma_{LV} \cos\theta$. T. C. TOYE

MOLECULAR THEORY OF LIQUIDS 532.7

532.72

64. The self-diffusion of liquid mercury. R. E. Hoffman. *J. chem. Phys.*, **20**, 1567–70 (*Oct.*, 1952).

Self-diffusion coefficients in liquid mercury have been measured by the capillary technique and have been found to be in disagreement with the earlier calculated values of Haissinsky and Cottin [Abstr. 2425 (1951)]. In view of the fact that the present data have been obtained by direct measurement and are also much more compatible with known viscosity data, it is concluded that the data of Haissinsky and Cottin are invalid. An examination of liquid self-diffusion data in general has shown that the Stokes–Einstein equation usually gives a much better correlation of self-diffusion and viscosity coefficients than the Eyring equation. A.

532.73

65. Co-operative orientation effects in solutions. J. A. Barker. *J. chem. Phys.*, **20**, 1526–32 (*Oct.*, 1952).

A general theoretical method for evaluating the effect on thermodynamic properties of co-operative orientation in solutions is developed. The theory is applied to the systems methanol + benzene, methanol carbon tetrachloride and chloroform + ethanol. Theoretical curves for excess free energy of mixing, heat of mixing, and excess entropy of mixing as functions of composition are presented and are in reasonable quantitative agreement with experimental values for the first two systems and qualitatively similar to the experimental curves for the third. It is concluded that the method provides a useful approach to the theory of solutions of associated liquids in general. A.

532.73 : 536.75

66. The entropy of solution of nonelectrolytes. J. H. Hildebrand and R. L. Scott. *J. chem. Phys.*, **20**, 1520–1 (*Oct.*, 1952).

The linear relation between the logarithm of the solubility of a solid nonelectrolyte and the logarithm of the absolute temperature [Abstr. 2472 (1952)] makes possible a rather accurate calculation of the partial molal entropy of transfer of the solute from solid to saturated solution. By subtracting from this the calculated entropy of fusion of the solid, one obtains the entropy of transfer from pure liquid to solution. This is several entropy units in excess of the ideal entropy in the case of solutions with high activity coefficients, but this difference is satisfactorily accounted for by the entropy involved in the expansion which accompanies the formation of such solutions under constant pressure. The entropy of mixing at constant volume seems to conform closely to the ideal (or Flory–Huggins) entropy. A.

532.739.2 : 535.345 : 536.21 : 539.32

A comparison of the solubilities of barium fluoride and calcium fluoride. *See Abstr.* 489

532.77 : 532.73

67. The free volume theory of multi-component fluid mixtures. Z. W. Salsburg and J. G. Kirkwood. *J. chem. Phys.*, **20**, 1538–43 (*Oct.*, 1952).

The free volume theory of the liquid state is

extended to multicomponent mixtures by using the method of moments in the treatment of the order-disorder problem. Retention of only the first moment yields an approximation to the partition function which has recently been studied by Prigogine and Garikian [Abstr. 5584 (1950)] and by Prigogine and Mathot [Abstr. 2686 (1952)]. An approximation equivalent to retaining the third moment is given and the calculation of the thermodynamic functions from the first moment approximation is discussed. A.

532.77 : 532.73

68. The third virial coefficient in polymer solutions. W. H. Stockmayer and F. Casassa. *J. chem. Phys.*, **20**, 1560–6 (*Oct.*, 1952).

With the aid of approximate models for the intermolecular potential energy, the third virial coefficient Γ_3 in the virial expansion for the osmotic pressure of a dilute polymer solution has been determined as a function of the second coefficient and one additional parameter obtainable from intrinsic viscosity or light scattering measurements. The theory and experimental results agree in indicating that the ratio Γ_3/Γ_2^2 for most solutions is markedly less than the value of $\frac{5}{8}$ given by the hard sphere molecular model proposed by others for the estimation of Γ_3. The limitations are discussed under which light scattering may be used for evaluation of the virial coefficients. A.

532.77 : 535.343.32–15

69. The optical properties of solutions of mixed salts. O. Matumura, A. Okazaki and Y. Matukura. *Mem. Fac. Sci. Kyūsyū Univ. B*, **1**, *No.* 1, 19–22 (1951).

The high values observed for the Verdet constants and the infra-red water band shifts of the mixed solutions (*a*) KI–I_2, (*b*) NaCl–KCl and (*c*) NaCl–KBr in water indicate the presence of unstable complex groups in each case. G. I. W. Llewelyn

MECHANICS OF GASES 533

533.15

70. Properties of *n*-pentforane and its mixtures with *n*-pentane. J. H. Simons and R. D. Dunlap. *J. chem. Phys.*, **18**, 335–46 (*March*, 1950).

533.15

71. The properties of *n*-butforane and its mixtures with *n*-butane. J. H. Simons and J. W. Mausteller. *J. chem. Phys.*, **20**, 1516–19 (*Oct.*, 1952).

The physical properties of *n*-butforane C_4F_{10} were determined and also these mixtures of it with *n*-butane C_4H_{10}. The properties of these two-component systems parallel very closely the system previously reported, *n*-pentforane and *n*-pentane (preceding abstract). The necessity of a concept such as that of "interpenetration" is confirmed. A.

533.15 : 539.155.2

72. Methods of increasing the efficiency of thermal diffusion columns. W. W. Watson. *Z. Phys.* **133**, *No.* 1–2, 272–5 (1952).

Experience with construction details and certain operating conditions for the improvement of the efficiency of thermal diffusion columns for isotope separation are discussed. A.

533.16

73. A possible cross-viscosity effect in air. H. Reiner. Letter in *Bull. Res. Coun. Israel*, **2**, 65–6 (*June*, 1952).

Reiner has proposed as the general equation connecting the tensors of stress (p_{rs}) and of flow (f_{tu}) in a viscous fluid, $p_{rs} = F_0\delta_{rs} + F_1 f_{rs} + F_2 f_{r\alpha} f_{\alpha s}$, and has called F_2 the coefficient of cross viscosity. Laminar flow of liquid between parallel or inclined planes, and flow between a rotating cylindrical and a coaxial nearly cylindrical surface are briefly discussed, and a short discussion of the motion of a very viscous liquid in which a cylinder rotates, the liquid not wetting the cylinder so that there is a narrow annulus of air between liquid and cylinder, leads to the conclusion that if the air has cross-viscosity, the air will be pumped from the outer atmosphere downwards and can be collected in the rotating cylinder provided the latter has a cover at the top but not at the bottom. This actually happens under appropriate conditions, the whole functioning as a centripetal air pump. J. S. G. Thomas

533.21 : 533.7

74. The compressibility of and an equation of state for gaseous neopentane. J. A. Beattie, D. R. Douslin and W. Levine. *J. chem. Phys.*, **20**, 1619–20 (*Oct.*, 1952).

The compressibility of gaseous neopentane (2–2-dimethyl propane) has been measured from 160·60°, the critical temperature, to 275° over a density range from 1 to 7 mole per litre, the maximum pressure being about 300 atmos. The constants of the Beattie–Bridgeman equation of state for the gas phase are $R = 0{\cdot}08206$, $A_0 = 23{\cdot}3300$, $a = 0{\cdot}15174$, $B_0 = 0{\cdot}33560$, $b = 0{\cdot}13358$, $c = 400\times10^4$ in units of normal atmos., litre per mole, °K (T°K $= t$°C $+ 273{\cdot}13$), the molecular weight being taken as 72·0924 g per mole. The second virial coefficients were determined graphically at each temperature. A.

533.21 : 533.7

75. The compressibility of krypton. I. An equation of state for krypton and the weight of a litre of krypton. J. A. Beattie, J. S. Brierley and R. J. Barriault. *J. chem. Phys.*, **20**, 1613–15 (*Oct.*, 1952).

The compressibility of krypton containing 0·90 mole % xenon has been measured from 0° to 300°C and over the density range 1 to 10 mole per litre. The constants of the Beattie–Bridgeman equation of state for the sample and for pure krypton were determined. The constants for pure krypton are $R = 0{\cdot}08206$, $A_0 = 2{\cdot}4230$, $a = 0{\cdot}02865$, $B_0 = 0{\cdot}05261$, $b = 0$, $c = 14{\cdot}89\times10^4$ in units of standard atmos., litre per mole, and °K (T°K $= t$°C $+ 273{\cdot}13$). The equation for the sample studied reproduced the observed pressures with an average deviation of 0·16%. The weight of one litre of Kr at a pressure of one standard atmosphere is calculated from the molecular weight (83·7) and the above constants to be 3·745 g per litre at 0°C and 3·474 g per litre at 70°F. A.

533.21 : 533.7

5. The compressibility of gaseous krypton. II. The virial coefficients and potential parameters of krypton. A. Beattie, J. S. Brierley and R. J. Barriault. *chem. Phys.*, **20**, 1615–18 (*Oct.*, 1952).

The second and third virial coefficients of a sample of krypton containing 0·90 mole % xenon have been determined from the compressibility measurements of Pt I. The parameters of the Lennard–Jones (6, 12) potential for krypton are $\mu = 2{\cdot}044\times10^{-58}$ erg-cm^6, $\lambda = 0{\cdot}438\times10^{-102}$ erg-cm^{12}, $\varepsilon = 238{\cdot}4\times10^{-16}$ erg, $b_0 = 58{\cdot}40$ cm^3 per mole, $\theta = 172{\cdot}7°$K, $\sigma = 3{\cdot}591\times10^{-8}$ cm, $r_0 = 4{\cdot}030\times10^{-8}$ cm. The representation of the second virial coefficient is quite satisfactory. The third virial coefficients diverge more than those of xenon from the theoretical values for a Lennard–Jones (6, 12) potential as tabulated by Hirschfelder, Spotz and Hirschfelder. The observed second virial coefficients agree moderately well with the tabulated values of Buckingham and Corner for an inverse sixth and inverse eighth power attractive and an exponential repulsive potential, when the tables are used in conjunction with the values of the arguments derived by Kane from data on the solid state of krypton and Born and Mayer's value of the exponent derived for neon. A.

533.5

7. Vacuum technique. A. L. Reimann. *London, Chapman and Hall* (1952) 449 *pp.*

An up-to-date, well-illustrated treatment on conventional lines, with extensive references in which the practical and physical principles, without detailed mathematics, are emphasized. Pumping speed, backing pumps, molecular pumps, mercury vapour pumps, oil vapour pumps, pump systems and pumping procedure, absorption of residual gases and manometers and vacuum gauges, form the subjects of individual chapters. Three chapters are devoted to glass and its manipulation, copper glass seals and matched-expansion and miscellaneous glass-to-metal seals, respectively. These chapters contain much useful information and descriptions of devices and techniques, some published for the first time and others not usually included in textbooks on vacuum technique.

S. WEINTROUB

533.6.01 : 517.9

A solution of the telegraph equation with application to two-dimensional supersonic shear flow. *See Abstr.* 3

533.6.011 : 534.222.2

78. Note on the distribution of singular directions of a two-dimensional shock. S. F. Shen. *J. Math. Phys.* **31**, 102–8 (*July*, 1952).

Theoretical. An extension of papers by Thomas [see Abstr. 6017 (1949); 1573–4 (1950)] the nomenclature of which is preserved. Thomas [Abstr. 1574 (1950)] defined a singular direction as being a value of α for which any one of the functions $G_n(M\ \alpha)$ vanishes ($n = 0, 1, \ldots, \infty$.); in the present paper α_m denotes the lowest value of α for which the particular function $G_m(M, \alpha)$ vanishes. It is pointed out that α_0 corresponds with the Crocco point, beyond which the curvature of the shock wave is infinite near the apex of the obstacle to which it is attached; in general α_m is the limit of existence of the mth derivative of the shock wave curvature. It is shown that $\alpha_d > \alpha_0 > \alpha_1 > \ldots > \alpha_m > \ldots > \beta$, where α_d is the shock angle producing maxm. stream deflection, and β is the minm. value of α giving subsonic flow behind the shock. It is concluded that if, for given Mach no. M, the vertex angle of a curved obstacle is gradually increased until subsonic flow begins to prevail behind the shock, the shock shape becomes non-analytic, the highest-order curvature derivatives becoming infinite first, followed by the lower order derivatives in turn, until finally the Crocco point ($\alpha = \alpha_0$) is reached. A. SCHOFIELD

MOLECULAR THEORY OF GASES 533.7

533.7

79. Relationships between transport properties of gases. E. R. Grilly. *Amer. J. Phys.*, **20**, 447–50 (*Oct.*, 1952).

Using reliable data on thermal conductivities K, viscosities η and specific heats c_v, values of the important ratio $f = K/\eta c_v$ have been determined over a wide range of temperature, 80–380°K, for 8 gases. For some gases the ratio shows a decrease with increasing temperature and for others an increase. The results and existing theories do not agree on all points. For a monatomic gas, He, f has a constant value up to 250°K, agreeing with most theories, but it drops at higher temperatures. One diatomic gas, H, shows a sharp drop, agreeing very well with Eucken's theory. Another diatomic gas, NO, shows a rise much sharper than predicted by the theory. Other diatomic and polyatomic gases show large deviations from Eucken's theory, mainly in that experimental values rise while the theory predicts a decrease with increasing temperature. A.

533.7

80. The influence of binary collisions on molecular [Knudsen] gas flow. J. W. Hiby and M. Pahl. Letter in *Phys. Rev.*, **88**, 414 (*Oct.* 15, 1952).

A formula is derived which expresses the effect of binary collisions in molecular gas flow (mean free path, $\lambda \gg$ characteristic dimension) as the ratio of the specific gas flow to its limiting value for ideal free-molecule flow ($\lambda \to \infty$). The formula is based on that for a long capillary tube [Abstr. 2376 (1948)] but contains an approximate correction for the "persistence of molecular velocities" derived from a distribution function [Abstr. 3373 (1952)] of the directions of scatter of molecules. Modified formulae for short pipes, narrow slots, orifices and porous media are compared with experimental data. For full-length papers see abstracts following.

W. H. DENTON

533.7

81. The influence of binary collisions on molecular [Knudsen] gas flow. I. Long tube of circular section. J. W. Hiby and M. Pahl. *Z. Naturforsch.*, **7a**, 533–41 (*Aug.*, 1952) *In German.*

An approximate calculation, based on methods developed by Pollard and Present [2376 (1948)] and the authors [Abstr. 128, 3373 (1952)] of the gas

transport as a function of the mean gas pressure. Comparison with experiment leads to a mean value of $f = 0{\cdot}98 \pm 0{\cdot}01$ for the Maxwell reflection coefficient (the fraction of molecules which undergo diffuse reflection at the walls) in H_2, N_2, O_2 and CO_2. The definition, significance and determination of f are discussed in detail. E. H. SONDHEIMER

533.7

82. The influence of binary collisions on molecular [Knudsen] gas flow. II. Gap between parallel plates; circular hole; short tube; porous medium. J. W. HIBY and M. PAHL. *Z. Naturforsch.*, **7a,** 542–53 (*Aug.*, 1952) *In German.*

The specific flow through a narrow gap decreases rapidly with increasing gas pressure p while the flow through a circular hole increases linearly with p, in agreement with experiment. For short tubes, and kinked tubes composed of short sections, the flow is always proportional to p, but the sign and magnitude of the proportionality factor depend sensitively on the ratio of length to diameter. Conflicting experimental results on Knudsen flow through porous media thus appear to be due to differences in the structure of the pores. The calculation of the coefficient of self-diffusion is discussed. E. H. SONDHEIMER

VIBRATIONS. ACOUSTICS 534

534.014.2

83. The "damping principle" and the problem of forced oscillations in an arbitrary domain. G. D. MALYUZHINETS. *Zh. tekh. Fiz.*, **21,** *No.* 8, 881–5 (1951) *In Russian.*

The author considers the problem of oscillations of a scalar quantity u satisfying the equation $\nabla u + \lambda u = F(x, y, z)$ in a domain G with the conditions on a boundary Γ in one of the two alternative forms, $u = 0$, $\partial u/\partial n = 0$ or $\partial u/\partial n + hu = 0$, where h is an eigenvalue. In view of the mathematical difficulties involved in the formulation and utilization of the "radiation condition," the author investigates the possibility of obtaining a unique solution of this equation by making use of the damping of the oscillations which his equations represent, following the tracks of Ignatovsky (1905), and Fock and Bursian (1926 and 1933). The solution is given in the form of a volume integral over the domain G, and it is sought as a function of complex variable. The mathematical conditions of the "damping principle" as applied to this form of solution are formulated and the proof of the uniqueness of the solution is given. N. S. JAPOLSKY

534.15 : 621.317.757

84. A photomechanical wave analyser for Fourier analysis of transient waveforms. T. B. WHITELEY AND L. R. ALLDREDGE. *J. sci. Instrum.*, **29,** 358–62 (*Nov.*, 1952).

A transient waveform to be analysed is made periodic by repetition. The resulting Fourier series components are simply related to the continuous frequency distribution of the original transient waveform. The film on which the transient to be analysed is recorded is placed in a variable speed revolving lucite drum. A photoelectric system regenerates the signal, which is applied to fixed tuned amplifier circuits. Changing the speed of rotation has exactly the same effect as changing the tuning of the analyser. Hence the analysis is performed by allowing the drum to slow down from maximum speed under frictional forces. By this means a large number of points on the frequency spectrum can be rapidly obtained and presented in the form of a permanent ink record. A.

534.21

85. On the dispersion of sound in a slightly non-homogeneous medium. M. L. LEVIN. *Zh. tekh. Fiz.*, **21,** *No.* 8, 937–9 (1951) *In Russian.*

The author points out that the theory of sound propagation developed by Rayleigh in para. 296 of his *Theory of sound*, could not be applied to a non-homogeneous medium because it omits the last term in the continuity equation $\partial\rho/\partial t + \rho \operatorname{div} \vec{v} + \vec{v} \nabla\rho' = 0$, where ρ is the density of the medium, ρ' is a small variation of ρ, and $\vec{v}$ is the velocity of the medium at a given point, and furthermore because in the Euler equation $\partial \vec{v}/\partial t = -(\nabla p')/\rho$, where p' is a small variation of the pressure, it assumes that p is proportional to the compression at a given point (the "local" compression) while in actual fact it should be proportional to the compression in a given portion of the moving medium (the "material compression") which differs from the former in a non-homogeneous medium. The author then gives a wave equation and its solution for a slightly non-homogeneous medium, and shows that the solution given by Rayleigh is a particular case of this more general solution.

N. S. JAPOLSKY

534.21

86. A remark on the "radiation principle." G. D. MALYUZHINETS. *Zh. tekh Fiz.*, **21,** *No.* 8, 940–2 (1951) *In Russian.*

The author points out that in the solution of the wave equation $\nabla u - k^2 u = 0$ the sense of the phase velocity does not necessarily coincide with the sense of energy propagation. He gives as an example a "ladder" electric circuit where these senses are opposite. N. S. JAPOLSKY

534.222.2 : 532.527

Formation of a vortex ring at the open end of a cylindrical shock tube. *See Abstr.* 62

534.23 : 541.138.2

87. Metallic corrosion influenced by ultrasonic waves. S. YAMAGUCHI. *J. appl. Phys.*, **23,** 1057–8 (*Sept.*, 1952).

The corrosion of coarsely polished magnesium in 5% saline water is less in water actuated by ultrasonic waves than in still water. This is explained on the grounds that the corrosion products form a colloidal suspension in water which shows thixotropic properties. Mechanical shock prevents coagulation of the colloidal corrosion products which remain so fine that they can form a compact layer which protects the metal from further corrosion. H. P. MYERS

534.23 : 536.49

88. Ultrasonic image conversion by means of a thermally induced colour change. H. H. RUST. *Angew. Chem.*, **64,** *No.* 11, 308–11 (1952) *In German.*

A new method of ultrasonic image conversion is

uggested for the non-destructive testing of materials y means of ultrasonics. The image conversion is rought about by the absorption heat of ultrasonics, nducing colour changes in thermochromic sub-tances, the most suitable of which is $Ag_2(HgI_4)$. A hin layer of this substance is deposited on an acetyl-ellulose film, thus yielding a highly sensitive "exposure naterial" analogous to a photographic film. De-cribes different methods of increasing the sensitivity f image conversion. Three examples are given in ome detail. F. LACHMAN

534.26

89. A connection between the problem of sound diffraction upon a sphere and the theorem of reciprocity. S. N. RZHEVKIN. *Zh. tekh. Fiz.*, **21**, *No.* 10, 1224–7 (1951) *In Russian.*

The author considers as an independent proposition a particular case of the reciprocity theorem, where a point B is remote and a point P is situated on a surface of an absolutely rigid sphere. Assuming that B is sufficiently remote from the sphere to allow spherical waves radiated from one of these two points to be regarded as plane waves when they reach the other, he derives in a standard way an expression for the sound-wave pressure at P for the waves radiated at B and then develops this expression in spherical harmonics [Legendre polynoms $P_m(\delta)$] with respect to the bearing angle δ between these two points as seen from the centre of the sphere. He compares his result with the expression for the sound-wave pressure created at B by the waves radiated from P, which was given in Morse's book (1948 and 1949), and finds that both expressions are identical, that is to say, that the waves radiated in B produce in P the same pressure as the waves radiated in P would have produced in B. N. S. JAPOLSKY

534.614 : 621.317.79

90. An apparatus for determining the velocity of an ultrasonic pulse in engineering materials. E. N. GATFIELD. *Electronic Engng*, **24**, 390–5 (*Sept.*, 1952).

The mechanical properties of several road materials, particularly concrete, may be determined by a non-destructive method based on measurements of the time of propagation of longitudinal vibrations at ultrasonic frequencies between two piezo-electric transducers placed in contact with opposite faces of the material. The distance between the transducers is accurately measured, and the results are usually presented as the velocity of propagation. The ultrasonic pulse technique is employed, and, for concrete, the ultrasonic frequency is usually 200 kc/s, with a pulse repetition frequency of 50 pulses/sec. Measurements of the time of propagation are made within the range 0–450 μsec, covering thicknesses of normal concrete up to 6 ft. The accuracy of measurement of the velocity is dependent on the path length and on the quality of the concrete, but is generally better than $\pm 0{\cdot}5\%$, corresponding to an error $\pm 0{\cdot}1$ μsec for test cubes of 10 cm path length. When longer path lengths are used, the accuracy is usually higher provided that an adequate signal is received. Details are given of the equipment used. A c.r.o. is used to measure the difference in time of transmission occurring when the transducers are in intimate contact and then separated by the thickness of material being tested. A trigger generator is used to control a time-marker generator simultaneously with an electrically shock-excited piezo-electric transmitter and a time-base sweep circuit. The timing marks appear on the c.r.t. superimposed on the signal generated by the piezo-electric receiving transducer. A.

534.632 : 538.551.6 : 621.317.361

91. Instantaneous measurement of a varying frequency. L. U. HIBBARD AND D. E. CARO. *J. sci. Instrum.*, **29**, 366–70 (*Nov.*, 1952).

It is shown that it is possible to observe the instant of passage of a rapidly varying frequency through a specified value by beating it with a fixed frequency reference signal. The method is particularly suitable for frequency-time functions which are linear or have an inflection at the point of observation. Errors due to non-linear functions are examined. The accuracy of measurement is dependent only on the rate of change of frequency. A feature of the method, with repetitive functions, is the automatic phasing of the fixed reference oscillator with respect to the varying frequency signal at the point of observation. A.

534.833

92. American and European standard methods for measurement of sound transmission in buildings. P. H. PARKIN. Letter in *J. Acoust. Soc. Amer.*, **24**, 542–3 (*Sept.*, 1952).

The difference between the American and European methods for measuring sound insulation and suchlike properties of buildings lies principally in the range of test frequencies used. The paper suggests modifications in the American system to bring it into line with European practice. A. B. WOOD

534.839

93. On plotting noise measurements. R. W. YOUNG AND R. M. SHERWOOD. Letter in *J. Acoust. Soc. Amer.*, **24**, 541 (*Sept.*, 1952).

A method is proposed for use with "constant-percentage" filters, whereby derived spectrum levels can be read directly from a graph of the original experimental data. G. F. HODSMAN

534.84

94. Recent progress in architectural acoustics. A. C. RAES. *Onde élect.*, **32**, 321–30 (*July*, 1952) *In French.*

Written primarily to be of assistance to those responsible for building projects. The first part deals with sound insulation of buildings and stresses the importance of the location, design of the structure, the floors, walls and methods of building. This is followed by a discussion of the acoustic properties of rooms and specimen results of reverberation measurements are given. Finally, brief reference is made to the use of acoustic materials. G. F. HODSMAN

534.843.4

95. The effect of direct and reflected sound on the sound distribution in rooms. J. GRUNERT. *Tech. Hausmitt. Nordwestdtsch. Rdfunks*, **4**, 138–41 (*July–Aug.*, 1952) *In German.*

Discusses what the author calls the hall-effect, i.e. the ratio of direct sound-energy to reflected sound-

energy, on the acoustic properties of a room. This is investigated by varying the positions of two sound sources and two microphones in the room. The use of many microphones and sound sources, as in a concert hall, is also considered. A. B. WOOD

534.844.1

96. A new device for reverberation measurements of rooms and loudspeakers. *Brüel and Kjaer tech. Rev., No.* 3, 16 *pp.* (*July*, 1952).

A special selector switch is described which, in conjunction with the high-speed logarithmic level recorder, makes it possible to record a complete frequency-sequence of reverberation curves on the one diagram. It is shown how these can be interpreted to judge the quality of the acoustics of a room, the presence of flutter echo, and other phenomena. In a brief summary included in the paper, reference is made to the use of the universal selector in the investigation of room acoustics with the "impulse glide method" developed by the B.B.C., for recording articulation diagrams in large lecture halls, and for the evaluation of the frequency characteristics and dynamic qualities of loudspeakers. A. B. WOOD

534.844.1

97. Frequency modulation in architectural acoustics. J. PUJOLLE AND R. LAMORAL. *Onde élect.*, **32,** 331–3 (*July*, 1952) *In French.*

The use of a frequency-modulated sound source for reverberation measurements is considered. Results are given of tests made at various frequencies and with different degrees and rates of modulation.

G. F. HODSMAN

OPTICS . RADIATION . SPECTRA 535

535

98. Light. R. W. DITCHBURN. *London and Glasgow: Blackie and Son* (1952) 68 *pp.*

A textbook covering experimental and theoretical optics, interference, diffraction, optical instruments, velocity of light, relativistic optics, polarized light, electromagnetic theory including reflection, refraction, absorption, dispersion and anisotropic media, photoelectric effects and quantum theory. The survey is very comprehensive and novel in many respects. The treatment is everywhere up-to-date although in many cases perhaps insufficiently detailed. The book is a valuable contribution to students and teachers and is particularly welcomed for the deliberate combining of classical wave optics and more modern quantum optics. Mathematical treatments are nowhere elaborate and, where necessary, mathematical appendices are introduced. Production and illustrations are excellent.

S. TOLANSKY

535.14

99. On the limiting concept of trajectory of a particle. A. BATTIG. *Univ. Nac. Tucuman Publ., No.* 467, 26 *pp.* (1949) *In Spanish.*

A discussion of this concept in the example of the interference of photons with non-vanishing rest mass near an imperfect reflector. L. PINCHERLE

535.223

100. Precision determination of the velocity of light derived from a band spectrum method. D. H. RANK, R. P. RUTH AND K. L. VANDER SLUIS. *J. Opt. Soc. Amer.*, **42,** 693–8 (*Oct.*, 1952).

The rotational constant B''_{000} for HCN has been measured using the 004 and 103 infrared rotation-vibration bands. A Fabry–Perot etalon was crossed on a high resolution plane grating spectrograph, used in conjunction with a multiple reflection absorption tube. The value of B''_{000} obtained is $1{\cdot}47830 \pm 0{\cdot}00002\ \mathrm{cm}^{-1}$. This same constant has been measured in pure frequency units in the microwave region by Nethercot, Klein and Townes. Their value for the constant is $44\,315{\cdot}9 \pm 0{\cdot}25$ Mc/s. The ratio of these two values gives directly the velocity of light in vacuum. The value so obtained is $c = 299\,776 \pm 6$ km/sec. The procedure used for precision determination of molecular constants, which makes complete use of experimental data, is described. A.

535.241 : 628.972

101. The use of the Luckiesh-Moss visibility meter for prescribing illumination. G. A. FRY. *Illum. Engng*, **47,** 391–6 (*July*, 1952).

Analyses the theory and method of use of the instrument and gives a curve calculated to show the relation between the relative visibility of a task and the illumination, as expressed by the number of log units above threshold. This is compared with the empirical relation found by Luckiesh *et al.* [Abstr. 7108 (1950)]. The discrepancies are ascribed to differences in the conditions of observation.

J. W. T. WALSH (R)

535.249

102. Apparatus for rapid transformation of photometric curves into blackening curves. H. JANESCHITZ-KRIEGL. *Chem.-Ingen.-Tech.*, **24,** 158–9 (*March*, 1952) *In German.*

An illustrated description of a simple mechanical apparatus for transforming photometric curves into intensity (blackening) curves, with particular reference to X-ray spectra of fibres and diffuse scattering curves.

F. LACHMAN

535.312 : 535.12

103. On the theory of the displacement of rays at the total reflection of spherical waves. L. M. BREKHOVSKIKH. *Zh. tekh. Fiz.*, **21,** *No.* 8, 874–80 (1951) *In Russian.*

Following the previous investigations of the problem by K. Artmann [Abstr. 3217 (1948)], C. v. Fragstein [Abstr. 4808 (1950)], F. Goos and H. Hänchen [Abstr. 1822 (1948)] and his own, the author gives a method of its solution, in which the falling spherical waves are specified exactly instead of being specified approximately. The problem is discussed solely on the basis of the theory of propagation of waves, without recurring to the electromagnetic theory of light. The reflecting medium is regarded as homogeneous in planes parallel to the reflection surface but generally non-homogeneous in the direction normal to this surface, and the rays are assumed to penetrate to some depth into the medium, reflecting from its strata. The reflected waves are analysed by a method of successive approximation. Particular attention is paid to the "caustics." N. S. JAPOLSKY

535.317

104. Cone channel condenser optics. D. E. WILLIAMSON. *J. Opt. Soc. Amer.*, **42,** 712–15 (*Oct.*, 1952).

Conical light pipes to condense radiation are attractive in their simplicity and low cost. In addition, when using detectors having non-uniform surface response, the non-image forming characteristics of such channels are desirable. Through the use of a field lens, channels may be designed which condense the radiation through a given area to the smallest possible size. As viewed from the output end of the channel, this corresponds to achievement of the optimum *f*/number of 0·6. Reflection losses in the experimental model described increased the *f*/number to 0·77. The cone channel described has the further advantage that it is not receptive to stray light. A.

535.317.3

105. Difference formulae for the calculation of optical aberrations of meridional bundles, with special reference to systems having telecentric ray paths in the image space. A. THOMESCHEIT. *Optik*, **9,** *No.* 8, 360–78 (1952) *In German.*

An extension of the difference formulae of Kerber is made, suitable for use with plane surfaces and telecentric rays, and allowing chromatic aberrations to be treated. The results are compared with those due to Kerber and to Staeble. 20 references.

R. W. FISH

535.324 : 535.345

106. The optical properties of liquid selenium. E. W. SAKER. *Proc. Phys. Soc.* [*London*] *B*, **65,** 785–7 (*Oct.*, 1952).

The optical properties of liquid Se in the near i.r. have been measured for a temperature range up to about 400°C. The absorption edge moves out to longer wavelengths as the temperature increases by an amount corresponding to a change of energy gap of $1{\cdot}4\times10^{-3}$ eV/C°. Absorption is very small at low frequencies. For long wavelengths the refractive index decreases as the temperature increases by an amount corresponding to the thermal expansion. A.

535.33.03 : 537.523.5

107. A water-cooled carbon arc source for infrared spectroscopy. C. S. RUPERT. Letter in *J. Opt. Soc. Amer.*, **42,** 684 (*Sept.*, 1952).

The arc is struck between carbons, and draws 25–27 A. Fluctuations in the radiation intensity are briefly discussed. J. D. CRAGGS

535.33.07

108. Use of interference wedge for projection of a spectrum. E. I. STERNS. Letter in *J. Opt. Soc. Amer.*, **42,** 686 (*Sept.*, 1952).

A spectrum of ample intensity is obtained by placing an interference wedge in the slide carrier of a projector with a yellow filter over the red end of the spectrum to remove blue light of the adjacent order.

R. W. FISH

535.33.07

109. A fixed-focus broad-range echelle spectrograph of high speed and resolving power. G. R. HARRISON, J. E. ARCHER AND J. CAMUS. *J. Opt. Soc. Amer.*, **42,** 706–12 (*Oct.*, 1952).

From the basic formulae governing echelle performance, simple expressions for echelle and groove dimensions are derived for producing a two-dimensional echelle spectrogram having any desired characteristics. Several possible mountings of Bausch and Lomb echelles having 200 grooves per inch and resolving powers in the range 200 000 to 500 000 have been tested with the objective of covering as much as possible of the spectral range 2000 to 7000 Å in a single exposure with high photographic speed. This type of spectrograph is of increasing importance for the analysis of complex spectra of materials available in only minute samples. The mounting thus far found most satisfactory involves making the light from a horizontal slit parallel with an 8-in. concave mirror of 10·5-ft focus, placing the echelle with its grooves horizontal in the resulting collimated beam nearly over the slit, and illuminating a 21-ft concave grating with grooves vertical with the slightly diverging parallel beams from the echelle. The vertical plate factor thus produced on 30 inches of plate set in the focal plane at the grating normal varies from 0·47 Å/mm at 7000 Å to 0·14 Å/mm at 2000 Å, and the spectral region from 7000 to 2000 Å can be covered in a single exposure at such dispersion. The reduction of optical parts to mirror, echelle, and grating gives high speed, so that exposure times of from 20 to 60 sec suffice for most arc spectra. To combine the echelle and grating characteristics effectively the spectrum below 3600 Å is made to overlap in the second order of the grating, that from 7200 to 3500 Å in the first. Measured resolving powers vary from 220 000 at 7000 Å to 450 000 or more at 2537 Å. Even in complex Zeeman spectra of the rare earths the statistical distribution of lines is found to be such that little interference results from the partial overlapping of two grating orders. The spectral images are found to be stigmatic and sharp out to 15 in. on either side of the normal to the grating. This echelle spectrograph is found to have more than twice the resolving power of the authors' best 35-ft concave grating mount, and from five to ten times its speed. Even with dispersion greater than that given by the grating instrument the plate length required is only 30 in. instead of 750 in. The spectrograph, which has the added advantage of being stigmatic, occupies 35 ft² instead of the 700 ft² required by the grating mount. This echelle instrument has been used to photograph at high field intensities the Zeeman effects of Er, Ho, Tb, Gd, Nd and Pr. A.

535.33.07

110. Applications of a modified spectrophotometer for microspectrometry, microdensitometry and continuous flame photometry. A. OPLER AND J. H. MILLER. Letter in *J. Opt. Soc. Amer.*, **42,** 784–5 (*Oct.*, 1952).

A recording Beckmann spectrophotometer [see Abstr. 165 (1952)] has been used for monitoring Na intensity in a flame fed from an ion exchanger column, and, after addition of microscope objectives, with 0·04 cm³ cells and for photometering spectrum plates.

G. F. LOTHIAN

535.33.07 : 535.375.5

111. The design of photoelectric Raman apparatus. W. R. Busing. *J. Opt. Soc. Amer.*, **42**, 774–8 (*Oct.*, 1952).

The performance of a photoelectric Raman spectrograph depends on the amount of luminant energy transmitted to the photomultiplier. An expression for this energy is found and this leads directly to certain principles to be followed in the design of such an instrument. The optimum sample shape is discussed and various types of sources are compared. A.

535.33.07 : 535.421

112. Slit curvature in grating monochromators employing single or multiple diffraction. C. S. Rupert. *J. Opt. Soc. Amer.*, **42**, 779–81 (*Oct.*, 1952).

The curvatures required for the entrance and exit slits of a grating monochromator and the wavelength errors at the ends of incorrectly curved slits are considered for cases of single and multiple traversal of the grating. Under certain conditions, a fixed curvature will provide zero error at slit ends for all wavelengths. In other cases, slits of fixed curvature can have correct shape for only one orientation of the grating. The best choice of this orientation is determined, and the range of angles over which the grating can be used is indicated. A.

535.33.07 : 535.822

113. Schwarzschild-Villiger effect in microspectrophotometry. L. Ornstein and A. W. Pollister. *Science*, **116**, 203–4 (*Aug.* 22, 1952).

The effect of lenticular glare, arising from reflections at the lens surfaces, is very serious in microspectrophotometry of cells having low natural contrast. This glare depends upon the illuminating cone and the area of the object illuminated. The theoretical approximation due to Naora is shown to depart from the actual values found in practical microscope systems. 17 refs. R. W. FISH

535.33.07–15

114. An optical slit mechanism. R. V. Jones. *J. sci. Instrum.*, **29**, 345–50 (*Nov.*, 1952).

A symmetrically opening slit mechanism, particularly suitable for i.r. spectrometers, is described. It employs parallel spring movements, operates for widths from 1 to 2000 μ and is suitable for use with curved jaws. Its operating torque is about 50 g cm which, with its rapid response and freedom from backlash, makes it suitable for automatic control. The jaws remain parallel to within about 3 sec, and the mid-line of the slit does not drift more than about 2 μ. Hysteresis between the driving micrometer drum and the measured slit with amounts to 0·2–0·3 μ, and may be due to an oil film. The slit jaws can be set so close together as to polarize the transmitted light completely. The slit mechanism, with a suitable rotational movement, has been applied to a twin-beam infra-red spectrometer; it has been demonstrated that entrance and exit slits must be alined to within a few seconds if satisfactory balance of the twin beams is to be achieved. An appendix describes a new all-spring reversing mechanism which enables the slit width to be controlled to better than 0·05 μ, and which is apparently completely free from hysteresis. A.

535.331

115. Identification and astronomical significance of the forbidden lines of iron and other metals. P. Swings. *Bull. Acad. Roy. Belgique Cl. Sci.*, **38**, *No.* 3, 253–63 (1952) *In French.*

The forbidden lines of Fe, in its successive stages of ionization from Fe I to Fe XV are discussed. Suggestions of new observational, experimental and theoretical investigations are made. The forbidden lines of other metals are briefly reviewed. A.

535.333

116. Spectra of material ejected from plaster by the impact of ultraspeed pellets. W. C. White and J. S. Rinehart. Letter in *J. chem. Phys.*, **20**, 1659 (*Oct.*, 1952).

535.338.333

117. Energy levels and wavelengths of the isotopes of mercury-199 and -200. K. Burns and K. B. Adams. *J. Opt. Soc. Amer.*, **42**, 716–21 (*Oct.*, 1952).

Electrodeless tubes containing 0·5 mg of Hg were excited by radiowaves of 110 Mc/s frequency. In the region 5790–2446 Å the wavelengths of 110 components of the complex lines in the first spectrum of Hg 199 have been measured relative to 5460·7532 Å with Fabry–Perot interferometers. Thirty-five lines in the first spectrum of Hg 200 were similarly measured. Fifty energy levels of Hg 199 were derived and their centres of gravity were compared with the levels of the even isotopes. The $6s^2\ {}^1S_0$ level was set at zero in all cases. The centres of gravity of the levels of Hg 199 fall between those of Hg 198 and Hg 200 but only one-seventh as far from the former as from the latter. For 18 well-determined centres the median difference between observed and interpolated is $\pm 0{\cdot}002\ \text{cm}^{-1}$. Fourteen centres of gravity involving 29 levels of Hg 201 were derived from the data of Schuler and Keyston or Schuler and Jones. The median difference between these centres and levels interpolated between even isotopes is $\pm 0{\cdot}004\ \text{cm}^{-1}$. Seven levels of Hg 204 (Schuler and Keyston, and Sterner) were compared with the levels of the other isotopes. The $6d^1\ D_2$ and $6d^3\ D_1$ levels are anomalous. Two hitherto unobserved lines of the type ${}^3P^\circ_1$–${}^3D_3$ furnish levels that indicate that unlike the ${}^3D_1$ and ${}^3D_2$ the ${}^3D_3$ levels are not inverted in the spectrum of Hg-199. A.

535.338.333

118. Isotope displacement in the atomic spectra of the rare earths. (The isotope displacement constants of Eu, Gd and Yb.) P. Brix. *Z. Phys.*, **132**, *No.* 5, 579–607 (1952) *In German.*

The isotope displacement for the S^2-configuration must be attributed to nuclear volume effects. The effect of the different masses is negligible. The pair Eu^{151}–Eu^{153} presents a very large isotope displacement which cannot be attributed to an anomaly of the electronic shells, but must depend on nuclear quadrupole moments. From the values of the constants are apparent certain empirical regularities. A method is also given for the analysis of uncompletely resolved spectrum line splittings due to nuclear moments.

L. PINCHERLE

535.338.334

119. Statistical theory of the effect of pressure on spectral lines. R. Bergeon, S. Robin and B. Vodar. *C.R. Acad. Sci.* [*Paris*] **235,** 360–1 (*Aug.* 4, 1952) *In French.*

Margenau's theory has been used, and repulsions, non-additive at high densities, have been taken into account. The displacements of the maxima can be expressed in a universal law for each combination of signs of α, β (these quantities appearing in the frequency distribution integral). J. JACOBS

535.338.4

120. Anomalous effective rotational temperature of HgH bands. R. K. Asundi, Jr. Letter in *Curr. Sci.*, **21,** 216–7 (*Aug.*, 1952).

Observations on the spectrum excited by a low-power oscillator. R. F. BARROW

535.338.4

121. Analysis of some vibration-rotation bands of the molecule OH. G. Déjardin, J. Janin and M. Peyron. *C.R. Acad. Sci.* [*Paris*] **235,** 538–9 (*Sept.* 8, 1952) *In French.*

The spectrum of an oxyacetylene flame is taken. The structure of the band (4, 0) is analysed. A large number of calculated and experimental frequencies are listed for the *P*, *Q* and *R* branches of the band, as well as the molecular constants. A. J. TAYLOR

535.338.4 : 535.343–15

122. Infrared emission and absorption of thermally excited carbon dioxide. R. H. Tourin. Letter in *J. chem. Phys.*, **20,** 1651 (*Oct.*, 1952).

This was measured under controlled conditions of temperature, pressure and composition up to 1100°C, at 62 mm Hg. The bands at 2·8 μ and at 4·3 μ were taken at 537°, 676° and 815°. The spectrum has been corrected for atmospheric absorption. A. J. TAYLOR

535.343

123. The absorption spectrum of hydrated americium chloride. B. J. Stover and J. G. Conway. Letter in *J. chem. Phys.*, **20,** 1490–1 (*Sept.*, 1952).

The positions and approximate intensities of absorption peaks between 3619 and 8180 Å are tabulated for room temperature and 77°K. G. F. LOTHIAN

535.343–14 : 538.561

124. Summarized proceedings of a conference on microwave physics—Oxford, July 1952. D. A. Wright. *Brit. J. appl. Phys.*, **3,** 337–41 (*Nov.*, 1952).

The papers read were: "Paramagnetic resonance in crystalline solids" (B. Bleaney); "Microwave phenomena in gases" (P. O. Hawkins); "Precision measurements with microwaves" (L. Essen); "Techniques and ultimate sensitivity in microwave spectroscopy" (E. E. Schneider). These are summarized at about 500 words each and the discussions are also reported.

535.343–15

125. On the infra-red absorption bands by water of crystallisation. O. Matumura. *Mem. Fac. Sci. Kyūsyū Univ., B,* **1,** *No.* 1, 1–3 (1951).

Transparency spectra are taken of a number of thin sulphate crystals containing various amounts of water, and of Rochelle salt. In each case several maxima are found near 3 μ which are assigned to water vibrations, and which show some displacement from the vapour H_2O band. The numbers of maxima are equal to the numbers of different classes of H_2O molecules in the crystals, as determined by X-ray analysis. The wave numbers of these displaced bands are calculated as a function of the OH distances. In some cases an expansion of the OH distance from 0·96 Å (normal distance) to 1·2 Å must be assumed to explain the observed frequencies, but in crystals this might well be possible. A. J. TAYLOR

535.343–15 : 539.133

126. Infra-red dichroism and protein structure. R. D. B. Fraser and W. C. Price. **Infra-red dichroism of tobacco mosaic virus nucleoprotein.** R. D. B. Fraser. Letters in *Nature* [*London*], **170,** 490–1 (*Sept.* 20, 1952).

An approximate analysis is made of the vibrational modes of the peptide group. The NH bending frequency near 1550 cm^{-1}, an ND bending frequency at 1130 cm^{-1}, and a further band at *c.* 1490 cm^{-1} are identified. The band at *c* 1270 cm^{-1} is tentatively identified. Orbital following is important for the transition moment associated with this last. Calculated values for the dichroic ratios of the 3300 cm^{-1} and 1650 cm^{-1} bands (15 and 4·1) from an oriented polypeptide are taken as evidence of the existence of the 3·7 residue helix in the configuration described by Pauling and Corey. The dichroisms of the absorption bands at 3300, 3065, 1657 and 1544 cm^{-1} from TMV nucleoprotein show that the major component of the protein in TMV exists in the α configuration, and that the chain axes are preferentially oriented perpendicular to the axis of the particle.

A. J. TAYLOR

535.343.2

127. On the assignment of the naphthalene bands at 3200–2900 Å. D. P. Craig and L. E. Lyons. Letter in *J. chem. Phys.*, **20,** 1499–500 (*Sept.*, 1952).

Absorption is measured from 2200–3300 Å, so that the weak system 2900–3200 can be compared with the intense system at 2200 Å. Polarized light is used parallel and perpendicular to the *C* axis of the crystals. The results obtained together with Raman data render an ^1A_g–$^1B_{3u}$ transition very improbable, and in spite of two objections the assignment A_g–A_g is favoured. A band system of *vibronic* species A_g–B_{2u} is found in the region 2500–2900. A. J. TAYLOR

535.343.2 : 548.7

128. Enhancement of the *F*- and *V*-bands in sodium chloride containing calcium. H. W. Etzel. Letter in *Phys. Rev.*, **87,** 906–7 (*Sept.* 1, 1952).

By adding Ca^{++} ions to NaCl the X-ray-induced *F* absorption band becomes more intense, but Cd^{++} ions produce only a small effect. It is held that each Ca^{++} ion introduced gives rise to a positive ion vacancy to preserve neutrality. Thus "hole" capture increases, electron-hole recombination decreases, and *F*-band absorption is enhanced. This is supported by manifold increase in the *V*-band absorption at 2100 Å for NaCl containing Ca^{++} ions.

G. F. J. GARLICK

535.343.2–15

129. Directional variation of frequency in the infra-red spectrum of crystals. L. Couture-Mathieu, J. A. A. Ketelaar, W. Vedder and J. Fahrenfort. Letter in *J. chem. Phys.*, **20,** 1492–3 (*Sept.*, 1952).

The infrared reflection spectrum of a cylinder of

quartz has been investigated. The frequency of two observed bands was found to increase with increasing longitudinal character of the incident wave, i.e. with decreasing values of the angle between the directions of electric moment and the propagative vector of the wave. G. I. W. LLEWELYN

535.343.2–15

130. New infrared absorption bands in *p*-type germanium. H. B. BRIGGS AND R. C. FLETCHER. Letter in *Phys. Rev.*, **87**, 1130 (*Sept.* 15, 1952).

Two new absorption bands, at 3·4 and 4·7 μ, are reported in samples of resistivities between 0·18 and 0·90 Ω cm. The absorption appears to be due to the impurities, and is probably proportional to the concentration of free holes. This leads to a cross-section of 1·5 Å^2 for the capture of photons by holes, and is very much larger than one would expect theoretically. P. T. LANDSBERG

535.343.4 : 537.523.5 : 535.33.07

131. Self-absorption in arc sources in thermal equilibrium. H. EDELS. *Proc. Phys. Soc.* [*London*] *B*, **65**, 794–800 (*Oct.*, 1952).

An analytical determination of the self-absorption of a spectral line emitted by a source is not normally possible if account is taken of the spatial variations in the source of the excited atom concentrations and spectral line profiles. The problem is simpler for uniformly excited sources, for example sources in thermal equilibrium, but not for high-pressure arc sources normally assumed to be in thermal equilibrium, because of the existence of temperature gradients. In the paper an analysis is developed which shows that if such arcs are treated as uniformly excited, an error of less than 5% is introduced into the determination of the self-absorption of spectral lines, emitted by transitions between an upper state s and a lower absorbing state t, which satisfy the limits $h\nu_{sq}/kT_0 \geqslant 10$ and $\nu_{st}/\nu_{tq} \leqslant 0{\cdot}5$, where q is the ground state and T_0 the axial source temperature. The theory is then applied to the experimental data for a h.p. Hg arc discharge and to new measurements of the line widths at 5461 and 4358 Å. It is shown that the calculated value of the self-absorption at 5461 Å agrees with the experimental value only when the line has a resonance profile. The existence of this form of profile is also indicated by considerations of the broadening processes in the discharge. A.

535.343.4 : 541.632

132. Rotational isomerism as a general property of alkyl nitrites. P. TARTE. *J. chem. Phys.*, **20**, 1570–5 (*Oct.*, 1952).

The i.r. and u.v. spectra of 15 alkyl nitrites were studied in the gaseous state. In the i.r., the O—N=O group is characterized by very strong absorption in the three regions 600, 800 and 1650 cm^{-1}, corresponding to O—N=O bending, N—O stretching, and N=O stretching frequencies, respectively. The doubling of the characteristic frequencies and the temperature dependence of the bands of methyl nitrite are explained by rotational isomerism, which appears to be a general property of alkyl nitrites. The influence of the length, shape and kind of the carbon chain on the frequencies and intensities of the characteristic bands has been studied. The intensity variation of the $\nu_{N=O}$ bands strongly suggests that the relative abundances of the two isomers vary widely from primary to secondary and tertiary nitrites, but depend only to a small extent upon the length and shape of the carbon chain. Application of this property to the diagnosis of primary, secondary or tertiary alcohols is suggested. The u.v. spectra consist essentially of two systems of diffuse bands (and not of one, as stated by previous workers), whose intensities vary in the same manner as the relative abundances of the two rotational isomers. The two systems of bands are accordingly assigned to these rotational isomers. This hypothesis has been checked by a study of the temperature dependence of the intensity of the bands. A.

535.343.4 : 551.510.41

133. The atmospheric window, 16 to 24 microns, and the second fundamental of nitrous oxide. A. ADEL. *Phys. Rev.*, **88**, 128 (*Oct.* 1, 1952).

Further investigation of the atmospheric window has disclosed the presence of the second fundamental of nitrous oxide, centred at 17 μ. All three fundamentals have now been located in the telluric spectrum. A.

535.343.4–14

134. Two D_2O microwave absorption lines. C. I. BEARD AND D. R. BIANCO. Letter in *J. chem. Phys.*, **20**, 1488–9 (*Sept.*, 1952).

The transitions $2_{2,0;2} \rightarrow 3_{1,3;-2}$ and $5_{3,2;1} \rightarrow 4_{4,1;3}$ were observed at 10 919·8 and 10 947·4 $\pm$ 0·1 Mc/s respectively and the identification confirmed by their Stark splitting. D. H. WHIFFEN

535.343.4–15

135. The absolute intensity of the ν_4 infrared absorption band of methane and its enhancement by nitrogen at high pressures. H. L. WELSH AND P. J. SANDIFORD. Letter in *J. chem. Phys.*, **20**, 1646–7 (*Oct.*, 1952).

See also Abstr. 4278 (1951). As the enhancement of an absorption band, produced by foreign molecules present, depends theoretically upon the polarizability, the concentration and the distance of closest approach of the foreign molecule, but not upon the frequency, one would expect the same fractional increase for different bands. This is measured for ν_4 of methane, when mixed with nitrogen (up to 300 atmos). The fractional increase in this case is found to be $2{\cdot}5 \times 10^{-4}$ per amagat of nitrogen, but $5{\cdot}4 \times 10^{-4}$ for the ν_3 band. It is concluded that the major part of the enhancement must be due to a distortion of the electron distribution of the absorbing molecule during close collisions. A. J. TAYLOR

535.343.4–15

136. The infrared spectra of PF_3, POF_3 and PF_5. H. S. GUTOWSKY AND A. D. LIEHR. Letter in *J. chem. Phys.*, **20**, 1652–3 (*Oct.*, 1952).

Assignments and force constants are given. D. H. WHIFFEN

535.343.4–15

137. Polarized infrared spectrum of sodium formate. R. NEWMAN. Letter in *J. chem. Phys.*, **20**, 1663–4 (*Oct.*, 1952).

535.343.4–15 : 535.375.56

138. Infrared and Raman spectroscopy studies of light and heavy trifluoroacetic acids. N. FUSON AND M.-L. JOSIEN, A. JONES AND J. R. LAWSON. *J. chem. Phys.*, **80**, 1627–34 (*Oct.*, 1952).

These studies show that the vapours at room temperature are composed of a mixture of monomeric and associated molecules. The principal bands corresponding to vibrations of the COOH and COOD groups have been identified for both the monomeric and the associated molecules by means of a comparative study of the two acids (*a*) in the vapour state at different pressures, (*b*) in CCl_4 solutions at various concentrations, and (*c*) in the liquid state. The monomeric carbonyl frequencies, influenced by the presence of the perfluoromethyl group, are the highest yet reported in the literature; this is true not only for CF_3COOH (1826 cm^{-1}, vapour), CF_3COOD (1823 cm^{-1}, vapour), but also for the ethyl ester, $CF_3COOC_2H_5$ (1802 cm^{-1}, vapour), the sodium salt, CF_3COONa (1687 cm^{-1}, solid) and the anhydride $(CF_3COO)_2O$ (1884 cm^{-1} and 1818 cm^{-1}, vapour). On the basis of a comparative study of the spectra of all these compounds, as well as of other perfluoromethyl compound spectra reported in the literature, the C — F stretching vibrations for the two acids have been assigned to the strong infrared absorptions at 1244 cm^{-1} and 1185 cm^{-1}. The corresponding Raman bands are very weak. A.

535.343.9 : 539.11

139. The absorption of light by noble metals and its relation to the van der Waals contribution to the cohesive energy. J. FRIEDEL. *Proc. Phys. Soc.* [*London*] *B*, **65**, 769–74 (*Oct.*, 1952).

Noble metals show absorption in the blue or ultraviolet; to this is due the colour of copper and gold. As was pointed out by Mott, the main absorption seems to be due to internal photoelectric effect, with excitation of a *d* electron. This absorption could be analysed—as for the alkalis—as a transition between two bands, described by Bloch orbitals, here *d* and *s*. But the correlation between the hole created in the *nd* shell and the Fermi electrons must be taken into account. The hole can be assumed to be screened by a $(n + 1)s$ electron bound to it, so that absorption should begin for the frequency of formation of the excited $nd^9(n + 1)s$ configuration of the monovalent ion. Agreement with experiment obtained using this model is satisfactory both in the pure metals and their alloys. The same model may be used for X-rays, and optical absorption energy is related to the energy separation between the *s* and *d* parts of *K* and $L_{II,III}$ emission bands. An order of magnitude for the van der Waals interaction energy between *d* shells could perhaps be deduced from the structure on the short wavelength side of the absorption peak. A.

535.345

140. Variation with temperature of the transparency of some optical materials in the Schumann region. A. GILLES AND B. VODAR. Letter in *J. Opt. Soc. Amer.*, **42**, 783–4 (*Oct.*, 1952).

Absorption increases greatly with temperature at short wavelengths. Results are quoted for quartz, corundum, lithium and calcium fluorides. Quartz windows are best for sealed absorption cells at high temperatures. R. W. FISH

535.345 : 532.739.2 : 536.21 : 539.32

A comparison of the transmittances of barium fluoride and calcium fluoride. *See Abstr.* 489

535.345 : 536.461

141. Determination of the local monochromatic absorption coefficient in "cracking" flames. F. GUYOMARD. *C.R. Acad. Sci.* [*Paris*] **235**, 358–9 (*Aug.* 4, 1952) *In French.*

At one end of a water-cooled hollow cylinder is placed a tungsten filament lamp; the other end of the cylinder is placed within the flame under examination. The flame and the lamp are viewed transversely by an optical pyrometer. If the observed brightness temp. with a particular lamp is β_1 and the corresponding brightness temp. with a different lamp is β_2, then, provided β_2–β_1 is kept const., the monochromatic absorption coeff. k is given by $d/dx[ln(\beta_2–\beta_1)]$ where x is a distance transverse to the flame axis. Application of this method to a flame of town gas enriched with propane shows that k attains a sharp max. in a zone midway between the flame axis and its outer edge; this is attributed to the local formation of carbon particles by "cracking." A. SCHOFIELD

535.345 : 539.234

142. The structure of evaporated metal films. L. HOLLAND. Letter in *J. Opt. Soc. Amer.*, **42**, 686 (*Sept.*, 1952).

A criticism of the paper published by R. S. Sennett and G. D. Scott [Abstr. 5741 (1950)]. The absorption coefficients for aluminium given as high as 25% and 32% in the visible are considered as abnormal and contrary to general experience. S. TOLANSKY

535.345 : 539.234

143. The structure of evaporated metal films. R. S. SENNETT AND G. D. SCOTT. Letter in *J. Opt. Soc. Amer.*, **42**, 686 (*Sept.*, 1952).

The criticism made by L. Holland (preceding abstract) is accepted and it is agreed that the absorption coefficients given for aluminium are abnormally high. S. TOLANSKY

535.345–15

144. Infrared absorption in high-purity germanium. H. B. BRIGGS. Letter in *J. Opt. Soc. Amer.*, **42**, 686–7 (*Sept.*, 1952).

Two curves of extinction *v.* wavelength, from 0·8–2·6 μ and from 2–25 μ resp., for single crystals. C. TURNER

535.345–15 : 535.5

145. Optical polarization in single crystals of tellurium. J. J. LOFERSKI. Letter in *Phys. Rev.*, **87**, 905 (*Sept.* 1, 1952).

Brief details are given of the determination of the transmission of very pure crystals in the infrared. The transmission is measured as a function of the polarization of the incident radiation relative to the *C*-axis of the crystal. The variation of the absorption constant with wavelength is shown graphically for the two directions of polarization. The refractive index, n, is about $5·3 \pm 0·2$ at 6 μ and no difference in the values of n for the two directions of polarization is detected. See Abstr. 1826 (1948), 2352–3 (1950), 2592 (1952). H. G. JERRARD

535.371

146. Luminescence of ice and tritiated ice. L. I. GROSSWEINER AND M. S. MATHESON. Letter in *J. chem. Phys.*, **20,** 1654–5 (*Oct.*, 1952).

Very pure ice shows an u.v. emission with maximum at 3400 Å when excited by 50 kV X-rays. The intensity of emission increases from −160 to −130°C. Tritiated ice shows a self-excited luminescence. Build-up and decay of luminescence are being investigated. G. F. J. GARLICK

535.371

147. Scintillators and energy transfer processes. C. REID. Letter in *Phys. Rev.*, **88,** 422 (*Oct.* 15, 1952).

The efficient scintillation solution involves: (*a*) high efficiency of solvent-solvent transfer of energy relative to non-radiative quenching processes in the solvent; (*b*) high probability of solvent-solute energy transfer relative to the reverse process; (*c*) high emission probability in the solute relative to quenching processes due to solute. The relation of these factors to the characteristics of practical scintillators is discussed. G. F. J. GARLICK

535.371.07

148. Uniform, nonhydrogenous, screens of ZnS-type phosphors. D. O. CALDWELL AND J. R. ARMSTRONG. Letter in *Rev. sci. Instrum.*, **23,** 508 (*Sept.*, 1952).

By gravity settling of ZnS–Ag phosphors from alcohol suspension on to a 5819 photomultiplier window, layers are obtained giving uniform pulse height distributions from mono-energetic Po α-particles. Optimum performance occurs for 7 mg/cm² coverage and for grain size $\sim 20\,\mu$. Pulse height spread is the same as that for scintillations from a thin, clear stilbene crystal under the same excitation conditions. G. F. J. GARLICK

535.372

149. Fluorescence studies of some simple benzene derivatives in the near ultraviolet. III. Benzotrifluoride. M. L. N. SASTRI AND H. SPONER. *J. chem. Phys.*, **20,** 1428–31 (*Sept.*, 1952).

The fluorescence spectrum of benzotrifluoride has been studied using various sources of excitation. The spectrum consists of about 36 bands for which assignments are given according to the symmetry properties of the molecule. The analysis is in agreement with that of the absorption spectrum. In the region of overlap, fluorescence and absorption bands show close coincidence. A.

535.372

150. Spectroscopic studies in the near ultraviolet of the three isomeric dimethylbenzene vapors. III. Fluorescence of meta dimethylbenzene. V. RAMAKRISHNA RAO AND M. L. N. SASTRI. *J. chem. Phys.*, **20,** 1552–3 (*Oct.*, 1952).

For Pt II, see Abstr. 7176 (1952). The fluorescence spectrum of *meta*-xylene has been obtained in low dispersion using Fe spark lines and a mercury arc lamp for excitation. About 26 bands were measured. They are discussed in their relation to the corresponding absorption spectrum. A.

535.375

151. Self recording of Raman spectra. J. BRANDMÜLLER AND H. MOSER. Note in *Naturwissenschaften*, **39,** *No.* 14, 325 (1952) *In German.*

Some remarks are made about the apparatus and experimental results described by Luther, Bergmann and Muhlfeld [Abstr. 8085 (1952)] based on similar experiments. A. J. TAYLOR

535.375.2

152. The near ultraviolet spectrum of formaldehyde. A. D. WALSH. Letter in *J. chem. Phys.*, **20,** 1502–3 (*Sept.*, 1952).

Gives formulae for the vibrational bands of the fluorescence spectrum of HCHO and DCDO and an analysis of the vibrational structure. C. TURNER

535.375.55

153. On the Raman effect in the aqueous solutions of some nitrates of rare earth elements. G. TOMITA AND H. NISI. *Mem. Fac. Sci. Kyūsyū Univ. B,* **1,** *No.* 2, 33–6 (1952).

The wave number of shift corresponding to the symmetrical vibration of nitrate ion is, as expected, almost independent of cation at a definite concentration. Moreover, it seems to decrease slightly with the increase of concentration and this may be explained by considering the structure of their aqueous solutions. A.

535.376

154. Saturation effect of plastic scintillators. C. N. CHOU. Letter in *Phys. Rev.*, **87,** 903–4 (*Sept.* 1, 1952).

Measurements of the non-linear variation of scintillation intensity with specific particle energy loss have been made for plastic and liquid scintillators using proton and negative pion beams. The saturation effect in plastic scintillators is less than that in phenylcyclohexane solutions. G. F. J. GARLICK

535.376

155. The nature of the saturation effect of fluorescent scintillators. C. N. CHOU. Letter in *Phys. Rev.*, **87,** 904–5 (*Sept.* 1, 1952).

The energy absorbed in a scintillator is assumed to reach the emitting molecules partly by radiative and partly by non-radiative, resonance processes. Curves of dL/dx *v.* dE/dx are obtained for different relative occurrence of these processes and those leading to quenching. G. F. J. GARLICK

535.376

156. Field dependent fluorescence of vitreous Zn_2SiO_4 phosphor. A. BRAMLEY AND J. E. ROSENTHAL. Letter in *Phys. Rev.*, **87,** 1125 (*Sept.* 15, 1952).

Zn_2SiO_4–Mn phosphor powder is embedded into thin glass strips (2 m × 0·01 cm) and these placed between electrodes with resulting electric field across the width of the strip. At room temperature the specimen is a semiconductor (resistance 5–100 meg/cm²) the resistance being dependent on temperature and on applied field frequency. Electroluminescence is observed for applied fields from 120 c/s to 16 kc/s and occurs at specimen-electrode boundary regions. G. F. J. GARLICK

535.393

157. A new photographic method of measuring the dispersion of the optical constants of metals. J. BOR. *Proc. Phys. Soc.* [*London*] *B,* **65,** 753–8 (*Oct.*, 1952).

The information from which the optical constants are determined is produced on a photographic plate as a vertical band of variable intensity for each wavelength. This is compared microphotometrically with

an adjacent band of graded intensity produced by the same wavelength. A.

535.393

158. The optical constants of thin metallic films deposited by evaporation. P. L. CLEGG. *Proc. Phys. Soc.* [*London*] *B*, **65**, 774–81 (*Oct.*, 1952).

The optical properties of evaporated films of Ag, Au, Sn and In have been determined by a photoelectric method. The influence of factors concerned with the evaporation procedure has been investigated in the case of the Ag films. The experimental results are accounted for by the agglomerated state of the films, and the application of Maxwell Garnett's theory is shown to lead to qualitative agreement with the experimental values. A.

535.417

159. Method of measurement for sedimentation, electrophoresis, and diffusion phenomena, using an apparatus with a great light-transmitting capacity. An instrument for the measurement of diffusion constants. H. J. ANTWEILER. *Chem.-Ingen.-Tech.*, **24**, 284–8 (*May*, 1952) *In German.*

Describes a new method based on the interference principle. Compared with the usual twin-slit interferometer, the new method makes full use of the great light-transmitting capacity of a Jamin type plane-parallel plate interferometer owing to the insertion of two plane-parallel plates of equal thickness arranged at an angle to one another. An apparatus for the measurement of diffusion constants is also described. F. LACHMAN

535.417

160. Interference filters in optics. K. M. GREENLAND. *Endeavour*, **11**, 143–8 (*July*, 1952).

A brief survey of types and applications. 30 refs.

535.417

161. Silvered films and dielectric multiple films in interferometry. D. A. JACKSON AND K. KUHN; A. H. JARRETT. Letters in *Nature* [*London*] **170**, 455–6 (*Sept.* 13, 1952).

It is considered that silvered Fabry–Perot etalons can achieve resolution probably better than that given by a corresponding instrument using multilayer dielectric films as described by Jarrett and K. von Klüber [Abstr. 5696–76 (1952)]. The reflecting and transmission characteristics of silvered films are considered to be equal to and at times better than those of the multilayers. Multilayers offer the advantage of a gain in the ultraviolet. Jarrett replies: The silvered films reported by Jackson and von Klüber are more efficient than those quoted by other observers. It is agreed that freshly prepared silver can equal multilayers. S. TOLANSKY

535.417

162. A laboratory method for determining the angles subtended by distant objects. K. GROSSFIELD. *J. Opt. Soc. Amer.*, **42**, 754–5 (*Oct.*, 1952).

A method is described for the determination of the small angle subtended by a distant object. Rays from the object are passed through a biprism, thus causing an interference pattern. If the object is considered as two separate sources, then by altering the position of the biprism the interference pattern caused by one of these sources may reinforce or blur the interference pattern caused by the other. A relation similar to that of a two-slit stellar interferometer has been derived and tested by experiment. Hence the angle subtended by the object can be evaluated. A.

535.42 : 534.321.9

163. The use of phase contrast to make visible secondary interference in the diffraction of light by ultrasonic waves. E. HEINEMANN. *Optik*, **9**, *No.* 8, 379–84 (1952) *In German.*

The formation of ultrasonic standing waves in a liquid may be rendered visible by a phase contrast system, since the wave pattern forms a phase grating. The contrast obtained is not as high as would be expected since the Doppler effect on the frequency reduces the amount of light able to interfere. Practical details of the apparatus used and sample photographs are given. R. W. FISH

535.421

164. The multiple-slit diffraction pattern. D. H. RANK. Note in *Amer. J. Phys.*, **20**, 453 (*Oct.*, 1952).

The multiple slit theory may be applied to the diffraction grating. There should be $(N - 2)$ secondary maxima between orders of the grating, N being the number of slits, and they should decrease in intensity extremely rapidly. The presence of this fine detail is demonstrated in the zero-order spectrum of $\lambda 5461$ of Hg. R. W. FISH

535.421

165. Successive diffractions by a concave grating. F. A. JENKINS AND L. W. ALVAREZ. *J. Opt. Soc. Amer.*, **42**, 699–705 (*Oct.*, 1952).

By placing one or more pairs of plane mirrors on the Rowland circle of a concave grating, adjusted so as to reflect the light back to the grating one or more times, dispersion and resolving power equivalent to a very high order of the grating may be achieved. The method is particularly advantageous when used with a strongly blazed grating. Actual tests with line and band spectra show a considerable increase over the theoretical resolving power for a single diffraction in the direction of blaze. Spectra diffracted as many as seven times are photographed, and show the ghost strength and freedom from overlapping characteristic of a single diffraction. Under suitable conditions, the astigmatism may be eliminated. A.

535.421

166. Replica technique for grating ruling engine adjustments. D. K. RICE AND F. A. MCNALLY. Letter in *J. Opt. Soc. Amer.*, **42**, 783 (*Oct.*, 1952).

A technique for observing cross-ruling patterns on gratings is described. This uses a master replica of known pattern and is said to give a considerable saving in time. R. W. FISH

535.421 : 538.566

167. On a multiple scattering theory of the finite grating and the Wood anomalies. V. TWERSKY. *J. appl. Phys.*, **23**, 1099–1118 (*Oct.*, 1952).

The formal multiple scattering solution obtained previously [Abstr. 2544 (1952)] for the scattering of a plane wave by an arbitrary configuration of parallel cylinders is applied to the finite grating of cylinders and to the reflection grating of semicylindrical bosses

on a perfectly conducting infinite plane. A far field solution in closed form for spacing large compared to wavelength and radius is obtained on neglecting the "end effects." It is found that for the transmission grating both polarizations may be markedly affected by multiple scattering; for the reflection grating, however, the effects are much more pronounced for polarization perpendicular to the elements. The case of radii $\ll\lambda$ is investigated in detail; the λ's for which the effects are greatest are determined, and various intensity curves are presented. The bright and dark bands appearing on these curves (overlaying the usual continuous spectra observed with broadband radiation) are similar to the "grating anomalies" discovered by Wood in 1902. The present analysis provides a simple physical interpretation of their presence in terms of the magnitudes and phases of the various orders of scattering. Simple relations for their dependence on the parameters are derived which agree in general with experimental results. Both the electromagnetic and acoustic cases are treated. A.

535.51 : 535.393

168. Photoelectric analysis of elliptically polarized light. J. F. Archard, P. L. Clegg and A. M. Taylor. *Proc. Phys. Soc.* [*London*] *B*, **65**, 758–68 (*Oct.*, 1952).

Two methods have been devised. One is a development of that of Kent and Lawson in which a rotating analyser yields a zero signal only when the light is circularly polarized. A double image prism is used after a rotating analyser and the two resulting modulated beams are in anti-phase only when the axes of the double image prism coincide with the axes of the vibration ellipse. In the second method, the light is modulated by chopping, and a double image prism selects two components in phase. In principle these are equal only when the axes of the double image prism are at 45° to the axes of the vibration ellipse. Thus the directions of the major and minor axes are found, and if the outputs from the two photocells which receive the two components are balanced on an electrical bridge the axial ratio may be obtained. The double image prism plays here the part of the half shadow device in visual observations, but as its half shadow angle is 90° instead of only a few degrees, the photocells are used under optimum conditions, i.e. the signal-to-noise ratio is maintained as large as possible and the potential accuracy of the method greatly exceeds the limitations imposed by the rest of the apparatus. By slight modifications the method may be made partially self-recording. Some examples are given of measurements made on metallic films undergoing surface changes. A.

535.65

169. Dye control with the *R*-Cam and ruler. B. S. Pritchard and E. I. Stearns. *J. Opt. Soc. Amer.*, **42**, 752–3 (*Oct.*, 1952).

The *R*-Cam, when used on the General Electric Recording Spectrophotometer in conjunction with a reference scale, provides a means for rapid prediction of reflectance curves from known dye formulations. Or, in the opposite case, it may be used for determination of dye concentrations from the reflectance curves of the mixture and of the constituent dyes at known concentrations. A.

535.65 : 612.843.31 : 621.397.2

170. Colour television: some subjective and objective aspects of colour rendering. G. T. Winch. *Proc. Instn Elect. Engrs, IIIA*, **99**, *No.* 20, 854–66 (1952).

For abstract see Abstr. 2654 (1952).

535.7 : 612.85

Physiological optics. *See Abstr.* 571–2

535.8 : 681.4

171. The generation of high aperture parabolic surfaces of revolution. R. E. Lewis, H. T. Betz, N. W. Rodelius and M. Wolfson. *Rev. sci. Instrum.*, **23**, 555–8 (*Oct.*, 1952).

An approximately parabolic blank is ground by stroking it with a thin blade held parallel to the axis of rotation. The blade carriage consists of a vertical motion parallelogram using thin flexing plates as bearings. This assembly is carried on a horizontal motion parallelogram which swings on an arc equal to the spherical approximation of the parabolic curve. The horizontal swing reduces the vertical motion required to the difference between the sphere and parabola, thus reducing the tendency toward grooving and chattering. Polishing may be accomplished on the machine by a blade of pitch-impregnated felt. A.

535.81 : 522.21

172. The use of heat deformation to yield a parabolic surface. A. Couder. *C.R. Acad. Sci.* [*Paris*] **235**, 491–3 (*Aug.* 25, 1952) *In French.*

A note describing experiments made during polishing and figuring a 47-in. mirror of some 24 ft focal length. Heating was applied through an annulus of wire at the back of the mirror and details are given of the size of the annulus, the current used and the accuracy achieved in securing the parabolic figure [see also Abstr. 2307 (1951)]. E. C. MARTIN

535.81 : 539.234

173. Effects of the evaporation technique on optical glass. C. F. Bruce. Letter in *Vacuum*, **1**, 300–1 (*Oct.*, 1951).

Tolansky [Abstr. 1674 (1952)] has reported permanent damage to glass or quartz optical flats sometimes occurring during cathodic sputtering. A similar effect has been observed in evaporating silver on to a polished flat. Interferograms are given showing permanent damage in the form of a hill, two light-waves high, extending over a disk of $\frac{3}{4}$ in. This may have been formed by violent local explosive evaporation. Standard cleaning methods did not remove the hill. S. TOLANSKY

535.822.9 : 535.42

174. A study in diffraction microscopy with special reference to X-rays. A. V. Baez. *J. Opt. Soc. Amer.*, **42**, 756–62 (*Oct.*, 1952).

The factors which affect resolution in diffraction microscopy are studied. The inequality $p\lambda > 4nd/N$ is a necessary condition for making good holograms, where p is the distance between source and film, d is the diameter of the source, and λ is its wavelength, n is the number of recorded central bands of the diffraction pattern, and N is the resolving power of the film. The minimum theoretical resolvable distance between two point objects is limited by d and N

but not by the wavelengths used in the analysis and reconstruction. Possible applications to the focusing of X-rays by Gabor techniques and by a single Fresnel zone plate are considered. A.

535.822.9 : 621.385.832 : 621.389

175. The flying-spot microscope. F. Roberts and J. Z. Young. *Proc. Instn Elect. Engrs, IIIA*, **99**, *No.* 20, 747–60 (1952).

For abstract see Abstr. 5063 (1952).

535.89 : 621.327.4

176. Electrodeless discharge lamps containing metallic vapors. M. Zelikoff, P. H. Wyckoff, L. M. Aschenbrand and R. S. Loomis. *J. Opt. Soc. Amer.*, **42**, 818–19 (*Nov.*, 1952).

Methods for producing and exciting electrodeless discharge lamps of a variety of metallic vapours are discussed. The design of a resonant cavity for use with a 2450 Mc/s microtherm unit in exciting the lamps is given. These lamps are long-lived and simple in construction and because of the great intensity of the principal lines, they are adaptable to photochemical uses. Satisfactory lamps were produced of Pb, In, Ga, Sb, Bi, Hg, Cd, Tl, Zn, Ca and Ba. A.

HEAT 536

536.21 : 532.739.2 : 535.345 : 539.32

A comparison of the thermal conductivities of barium fluoride and calcium fluoride. *See Abstr.* 489

536.24

177. Distribution of heat-transfer coefficients around circular cylinders in crossflow at Reynolds numbers from 20 to 500. E. R. G. Eckert and E. Soehngen. *Trans Amer. Soc. Mech. Engrs*, **74**, 343–7 (*April*, 1952).

An experimental investigation using the Zehnder Mach interferometer reveals the temperature field around heated cylinders in an air stream normal to the axis. From the temperature distribution the local distribution of the heat-transfer coefficient around the cylinder circumference is obtained. The thermal boundary layers are quite thick, especially for the lower Reynolds numbers investigated and the separation occurs farther downstream than at high Reynolds numbers. Accordingly, the contribution of the stagnant region at the downstream side of the cylinder to the over-all heat transfer is low (approximately 15%), and the heat flow into the upstream side is much larger than into the downstream side. A.

536.24

178. An attempt to explain a discrepancy in observations of the heat transfer between a vertical surface and a fluidized bed of particles. M. Jakob. Letter in *J. appl. Phys.*, **23**, 1056 (*Sept.*, 1952).

An equation published by Dow and Jakob (1951) has a different exponent from that of van Heerden *et al.* (1951). The difference is explained on the assumption that fluidization induces a difference in heat exchange mechanism at the surface so that heating and cooling experiments do not obey the same laws. E. H. DOCK

536.25

179. Significance of flow patterns for initial convection in porous media. H. L. Morrison and F. T. Rogers, Jr. Letter in *J. appl. Phys.*, **23**, 1058–9 (*Sept.*, 1952).

The latest theories and calculations on the initiation of convective flow do not agree. Observations have now suggested that flow patterns can only be explained by modifying the fundamental flow laws. Results point to a more nearly valid understanding of available data. E. H. DOCK

536.421.1

180. Fusion as hydrodynamic instability in thermal wave propagation. G. Bonfiglioni. Letter in *Phys. Rev.*, **87**, 897 (*Sept.* 1, 1952).

Due to non-linear effects, a sinusoidal wave of finite amplitude becomes a shock wave at a certain distance from its source. It is suggested that melting occurs when this distance becomes comparable with the atomic spacing. Lindemann's formula emerges, and agreement with experiment is improved by considering transverse waves only. R. O. DAVIES

536.424

181. Transition temperatures in solid solutions of ammonium chloride and ammonium bromide. A new transition in pure ammonium bromide. C. C. Stephenson and H. E. Adams. Letter in *J. chem. Phys.*, **20**, 1658–9 (*Oct.*, 1952).

Results of new measurements with a simple cooling-curve apparatus are in agreement with those obtained by Mandleberg and Staveley (1950). Preliminary information is given of a new transition in NH_4Br at *c.* 78°K on cooling, and 108·5°K on warming. F. LACHMAN

536.424

182. Phase transitions of the barium dicalcium *n*-butyrate. S. Kondo and T. Oda. Letter in *J. chem. Phys.*, **20**, 1659 (*Oct.*, 1952).

See also Abstr. 1349 (1952). $BaCa_2(CO_2CH_2CH_2CH_3)_6$ presents two phase transitions; one at 5·2° and one at 50·2°. These are found by dilatometry as well as by differential thermal analysis. It is concluded that in the lowest anisotropic phase the rotational motion of the *n*-butyrate ion at room temperature is frozen and assumes lower symmetry. The upper transition, which is weaker, can be related to the positional transfer of the oxygen atoms of the carboxyl groups. A. J. TAYLOR

536.44

183. Note on the critical temperature of solids. B. J. Alder and G. Jura. Letter in *J. chem. Phys.*, **20**, 1491–2 (*Sept.*, 1952).

The possible existence of a solid-liquid critical point is tested by estimating independently the liquid and solid energies and finding where they coincide. An explicit treatment of melting is thus avoided. This method does predict critical points for some rare gases. Their co-ordinates are:

	He	Ne	A
T_c (°K)	90	540	1840
$10^{-3}p_c$ (atmospheres)	29	150	250

R. O. DAVIES

536.453 : 669

184. Centrifugal furnace heated by solar energy. F. Trombe and M. Foëx. *C.R. Acad. Sci.* [*Paris*] **235,** 571–3 (*Sept.* 15, 1952) *In French.*

Solar radiation is led into the furnace through a small diameter tube. The body of the furnace is cylindrical (300 cm^3–1000 cm^3) and rotates at 200–5000 r.p.m. The powdered charge is kept in contact with the cooled metal walls by the rotation but the central core melts under the action of the concentrated heat. The main body of the charge insulates the walls from the intense heat. Gas can be passed through the furnace to produce desired conditions. Temperatures in the region of 3000°C have been obtained for the melting of Al and quartz and the treatment of zircon. E. H. DOCK

536.46

185. Flame propagation in carbon monoxide. G. McDonald. Letter in *J. chem. Phys.*, **20,** 1497–8 (*Sept.*, 1952).

It has been found experimentally that the flame-speed at N.T.P. in a dry mixture of 80% CO–20% O_2 is 27·0 cm/sec, and that in a dry mixture of 47% CO–53% air is 14·9 cm/sec. It is pointed out that this difference in flame speeds of dry mixtures having equivalent CO–O_2 ratios is in disagreement with the H-atom-diffusion theory of CO-air flame structure developed by Tanford and Pease (1947). A. SCHOFIELD

536.461 : 537.523.4

186. Microchronometric schlieren study of gaseous expansion from an electric spark. H. L. Olsen, R. B. Edmonson and E. L. Gayhart. *J. appl. Phys.*, **23,** 1157–62 (*Oct.*, 1952).

Gaseous phenomena induced by short-duration sparks at atmospheric pressure have been photographed during the first microseconds of their existence by a flash-schlieren technique. The growth of the heated gas domain (kernel) expanding from the spark discharge has been observed for air and argon. The kernel continues to expand rapidly, but subsonically, after the spark current ceases and after the shock wave separates. It develops further into a torus about the spark electrodes and eventually decays. The development of flame from a heated gas kernel in an inflammable mixture is illustrated. Energy relationships for the expanding argon kernel are discussed. A.

536.48 : 536.423.4

187. The condensation of nitrogen in a hypersonic nozzle. W. W. Willmarth and H. T. Nagamatsu. *J. appl. Phys.*, **23,** 1089–95 (*Oct.*, 1952).

A small, stainless steel, two-dimensional source flow nozzle supplied with bottled N was used for the condensation investigation. It was found that the N supersaturates approximately 15°K or 1·2 Mach numbers when expanded from stagnation conditions of 70°F and pressures of 8·21 and 16·15 atm. A numerical method for solving the equations of motion with the aid of the experimental data allows the computation of the fluid temperature during the condensation process. The addition of small amounts of CO_2 reduced the degree of supersaturation obtainable with bottled N. A.

536.48

188. Vapor pressures of He^3 — He^4 mixtures below the lambda point. H. S. Sommers, Jr. *Phys. Rev.*, **88,** 113–27 (*Oct.* 1, 1952).

The methods used are absolute, giving directly the vapour pressure as a function of temperature, liquid phase concentration, and vapour phase concentration. The concentrations are determined from the measured abundance ratios of the room temperature gases without the necessity of withdrawing samples from the cryostat. The He^3 concentrations studied ranged up to 80% for the vapour phase and 13% for the liquid phase, while the temperature interval was 1·30–2·18°K. From these measured pressures are deduced the vapour pressures as a function of temperature and vapour phase concentration and as a function of temperature and liquid concentration, the He^3 distribution function, and latent heats of evaporation. Analysis of the experimental results on rather general grounds shows there is a significant repulsive potential energy between the two isotopes. At constant temperature the mixing should thus be accompanied by heat absorption, while adiabatic mixing should lower the temperature. On the basis of classical solution theory, the mutual repulsive potential energy leads to a separation into two liquid phases around 0·7°K. A.

536.48

189. The solidification curve of helium II. B. M. Cwilong. Letter in *Phys. Rev.*, **88,** 135 (*Oct.* 1, 1952).

From experiments with apparatus eliminating "He II wire" heat leakage, it is concluded that the melting curve and all other curves formerly obtained for He II under pressure are considerably stretched out along the temperature axis towards 0°K; all these curves therefore really represent much shorter and steeper sectors. R. B. DINGLE

536.48 : 532.528

190. Cavitation effect in helium II. B. M. Cwilong, J. F. Lees and F. D. Manchester. Letter in *Phys. Rev.*, **88,** 138 (*Oct.* 1, 1952).

Observations of a cavitation effect serve as a warning against assuming thermal equilibrium in demagnetization experiments on powdered paramagnetic salts diluted with He. R. B. DINGLE

536.48

191. Helium film transport over copper below 1°K. L. Lesensky and H. A. Boorse. Letter in *Phys. Rev.*, **87,** 1135–6 (*Sept.* 15, 1952).

The transport rate of the He II film over clean machined Cu was found to be constant between 1·5°K and 0·9°K, with indications of a rise below 0·8°K. The rate over contaminated machined Cu was much higher, and showed a much more pronounced rise at the lower temperatures. R. B. DINGLE

536.48

192. The effect of He^3 ingredient on the thermal Rayleigh disc torque. S. Koide and T. Usui. Letter in *Progr. theor. Phys.*, **6,** 622–3 (*July–Aug.*, 1951).

This is derived and evaluated numerically on the basis of a theoretical treatment of sound propagation in He^3–He^4 mixtures by the same authors [Abstr. 8138 (1952)]. H. LONDON

536.532 : 621.317.79

193. Portable temperature-indicating instruments for connection to thermocouples. A. EBINGER. *A.E.G. Mitt.*, **42**, 180–4 (*July–Aug.*, 1952) *In German.*

Temperature measurement with thermocouples requires for the indication moving-coil instruments with particularly high voltage-sensitivity. Three laboratory types of indicating instruments, their external design and their electrical properties are described in detail and illustrated. A table shows the range of application and the thermo-electric voltage of some thermocouples. The indicating instruments described are a small and a large pointer instrument and a light spot instrument. The small pointer instrument is particularly suitable for control measurements in service, the large pointer instrument, possessing precipitation hardened Al–Ni magnets, for exact investigations in the laboratory and for the calibration and control of service instruments, and the light spot instrument, fitted with a friction-free band support, for measuring particularly small temperature rises in windings and the like.

R. NEUMANN (R)

536.532 : 621.395.65 : 621.318.563

194. A versatile equipment for thermocouple switching using a Post Office type uniselector. H. BURTON AND S. F. SUFFOLK. *J. sci. Instrum.*, **29**, 350–2 (*Nov.*, 1952).

Errors which may be introduced by the use of a Post Office type uniselector for the switching of thermocouples are considered. Methods of overcoming these errors are described. Details are given of a switching unit to connect up to 50 thermocouples in succession to either an indicator or a recorder. A.

536.628.3

195. Measurement of heats of transformation by means of the differential thermal analysis. G. SABATIER. *C.R. Acad. Sci.* [*Paris*] **235**, 574–5 (*Sept.* 15, 1952) *In French.*

In order to reduce the variability of the heat conductivity k from one sample to another and during the transformation itself, it is suggested to use as sample not the pure substance tested but its mixture with the reference sample substance, the minimum "concentration" of the sample tested being 20%. The area S between the two thermal analysis curves is substantially decreased, thus lowering the accuracy of evaluation of the heat of transformation Q from the formula $S = (\alpha/kl)Q$, where α is a pure number depending upon the form, and l—a length characteristic of the dimensions of the apparatus; yet the almost perfect thermal symmetry of both crucibles warrants the use of temperature recorders of high sensitivity. F. LACHMAN

536.63 : 536.75

196. Thermodynamic properties of diacetylene. S. M. FERIGLE AND A. WEBER. Letter in *J. chem. Phys.*, **20**, 1657 (*Oct.*, 1952).

Using the new assignment of vibrational frequencies given by Jones [Abstr. 2629 (1952)], the heat content, free energy, entropy and heat capacity are calculated for temperatures between 100° and 1000°K. C. TURNER

536.631 : 536.75

197. Calculated thermodynamic properties of GeF_4. F. L. VOELZ. Letter in *J. chem. Phys.*, **20**, 1662 (*Oct.*, 1952).

Using the infrared spectrum as published by Woltz and Nielsen [Abstr. 2627 (1952)] the heat content, free energy, entropy and heat capacity were calculated for temperatures between 100° and 1000°K. C. TURNER

536.631 : 537.312.62

198. Theoretical and experimental heat capacities of superconducting metals. R. D. WORLEY, M. W. ZEMANSKY AND H. A. BOORSE. Letter in *Phys. Rev.*, **87**, 1142 (*Sept.* 15, 1952).

A careful examination which includes recent experimental data shows good agreement with Koppe's general specific heat curve [Abstr. 1558 (1948)]. H. LONDON

THERMODYNAMICS 536.7/.8

536.7

199. Some thermodynamic properties of formic acid. W. WARING. *Chem. Rev.*, **51**, 171–83 (*Aug.*, 1952).

Gives tables, based on a self-consistent treatment combining statistical calculations with thermal data. Results are given for the monomer considered as an ideal gas and for the real vapour in dimerization equilibrium at various temperatures and pressures, together with some properties of the saturated liquid and the ideal gas dimer. 41 refs. A.

536.7

200. Tables of the Lennard–Jones and Devonshire equation of state at high temperatures and densities. W. FICKETT AND W. W. WOOD. *J. chem. Phys.*, **20**, 1624–6 (*Oct.*, 1952).

The Lennard–Jones and Devonshire equation of state is computed for the following ranges of the reduced variables: temperature, kT/ϵ^*, 20 to 150 in steps of 10; volume, v/v^*, 0·3 to 0·7 in steps of 0·05 and 0·7 to 1·3 in steps of 0·1. A.

536.7 : 539.132

201. Thermodynamic properties of the diatomic interhalogens from spectroscopic data. L. G. COLE AND G. W. ELVERUM, JR. *J. chem. Phys.*, **20**, 1543–51 (*Oct.*, 1952).

The thermodynamic functions C_p^0, S^0, $-(F^0 - E_0^0)/T$, and $(H^0 - E_0^0)/T$ of the six diatomic interhalogens, ClF, BrF, IF, BrCl, ICl and IBr, have been evaluated as a function of temperature from 298·16°K to 2000°K by the application of statistical methods. These results have been combined with newly evaluated properties of the F, Cl, Br, and I atoms and molecules to yield the heats and free energies of dissociation and dissociation constants for the equilibria between the interhalogens and their molecular and atomic dissociation products. The calculations are based on available experimental spectroscopic constants with the exception of the anharmonicity term and internuclear distance for BrCl and of the internuclear distances in IF and IBr. These quantities are estimated empirically. A.

536.71

202. The quantum mechanics of assemblies of interacting particles. T. MATSUBARA. Letter in *Progr. theor. Phys.*, **6**, 899–901 (*Sept.–Oct.*, 1951).

For a system of N identical particles the Slater sum of the system is calculated as a power series in $1/kT$, the general term being given, and a recurrence relation is found for the coefficients of the expansion of the density matrix in powers of the interaction energy.

R. H. DALITZ

536.75

203. Thermodynamic properties of chlorine trifluoride. A. WEBER AND S. M. FERIGLE. Letter in *J. chem. Phys.*, **20**, 1497 (*Sept.*, 1952).

Points out that the agreement claimed by Scheer [Abstr. 5753 (1952)] to exist between the value of the entropy of ClF_3 calculated by himself from spectral data and that given by Grisard *et al.* from thermal measurements is fortuitous. F. LACHMAN

536.75 : 532.73

The entropy of solution of nonelectrolytes. *See Abstr.* 66

536.782

204. On the use of the Joule–Thomson effect to measure the work equivalent of heat. Thermodynamic theory. J. R. ROEBUCK. *J. appl. Phys.*, **23**, 1119–21 (*Oct.*, 1952).

The Joule–Thomson porous plug experiment is described, its quantitative aspects indicated and the constant enthalpy condition set up. The experimental plan for the proposed measurement is described and a short analysis of the physical situation in the fluid given. The standard equation for the Joule–Thomson coefficient is applied to the situation and details are given of how this equation may be integrated for two special physical situations. The information necessary for these integrations is discussed and physical means described for obtaining it. A numerical integration may be used for obtaining the work equivalent of heat (J) with a high precision corresponding to the high precision with which these various data may be measured. A.

ELECTRICITY 537

THEORY . ELECTRONS 537.1

537.12

205. The Rydberg constant and the atomic mass of the electron. E. R. COHEN. *Phys. Rev.*, **88**, 353–60 (*Oct.* 15, 1952).

A re-evaluation of the spectroscopic data pertinent to the Rydberg constant and the atomic mass of the electron yields the values $R_\infty = 109\,737{\cdot}326 \pm 0{\cdot}014\ \text{cm}^{-1}$ and $m = (54{\cdot}895 \pm 0{\cdot}008) \times 10^{-5}$ a.m.u. If the "microwave" value of the electron atomic mass, $m = (54{\cdot}8785 \pm 0{\cdot}0019) \times 10^{-5}$, is used, the Rydberg constant is $R_\infty = 109\,737{\cdot}311 \pm 0{\cdot}012\ \text{cm}^{-1}$ It is furthermore concluded that Houston's and Chu's data can be brought into agreement with that of Drinkwater, Richardson, and Williams by ascribing the discrepancy to differences in wavelength standards used by these investigators. A.

ELECTROSTATICS . DIELECTRICS 537.2

537.21 : 538.31

206. A new vector identity and physical application. E. B. MULLEN. Note in *Amer. J. Phys.*, **20**, 453–4 (*Oct.*, 1952).

A new vector identity for the gradient of the scalar product of two vectors is derived and its application to electrostatics shown. In particular the equivalence of a closed circuit carrying a current and a magnetic shell is proved without the aid of vector potential. The Biot–Savart law is also derived. A. V. BREHME

537.226.2

207. On the dielectric properties of tungsten trioxide. K. HIRAKAWA AND T. OKADA. *Mem. Fac. Sci. Kyūsyū Univ. B*, **1**, *No.* 1, 1–8 (1951).

The permittivity of sintered specimens at 2 kc/s passes through a peak of about 4×10^4 at 10°C for the pure material, the peak approaching 8×10^4 and occurring at about 60°C when 0·7 atomic % Na is present. Measurements over 500–4000 c/s suggest a simple relaxation process, but a hysteresis loop was demonstrable at 60 c/s for temperatures below 150°C. Single crystal specimens seen in polarized light show parallel line patterns, interpreted in terms of ferroelectric domains. The size of the domains shows some inverse relation to the impurity concentration but does not appear to be affected by the electric field. Wedge-shaped boundary domains are very strain sensitive. The high conductivity renders electric-measurements difficult. F. F. ROBERTS

537.226.2

208. Domain properties in $BaTiO_3$. W. J. MERZ. Letter in *Phys. Rev.*, **88**, 421 (*Oct.* 15, 1952).

Microscopic investigations of the orientations and magnitudes of the ferro-electric domains in good single crystals of $BaTiO_3$ under conditions where d.c. electric fields are applied along given directions are reported. By simultaneous observation of domain movement and the hysteresis loop on application of an electric field it is found to be energetically easier to create new domains than to enlarge an existing domain. C. A. HOGARTH

537.226.2 : 537.228.1 : 548.7

209. Piezoelectricity, ferroelectricity, and crystal structure. A. VON HIPPEL. *Z. Phys.*, **133**, *No.* 1–2, 158–73 (1952).

By visualizing polar crystals as a network of permanent dipole moments, the piezo- and ferroelectric properties of dielectrics may be derived from the standpoint of molecular symmetry. This approach is used to clarify the relation between the sphalerite and wurtzite structures, the ferroelectric feedback effect in barium titanate, aspects of domain formation, and the interrelationship between ferro- and piezoelectricity. A.

537.226.2 : 621.3.011.5 : 621.315.61

210. The dielectric properties of certain benzene derivatives in the solid state. A. TURNEY. *Instn Elect. Engrs Paper* 1393, 8 *pp.* (1953). Based on *Rep. Brit. Elect. Res. Assoc. Ref. L/T* 270.

Gives the results of an investigation of the dielectric properties of two chlorine-methyl substituted benzenes, pentachlortoluene and 1, 2, 4 trimethyl, 3, 5, 6 trichlorbenzene and of pentaiodobenzene, over the frequency range 50 to $4{\cdot}8\times10^{10}$ c/s, and discusses the observed behaviour in terms of modern dielectric theory. It was thought possible that these materials would exhibit resonance absorption owing to rotational molecular oscillation at the upper end of this frequency range. This phenomenon was not observed, but study of the dipolar absorption in the chlorine-substituted compounds showed this to be characterized by a very narrow band of relaxation times, approximating closely to a single relaxation time. A quantitative estimate of the breadth of the relaxation time distribution was made. Directional permittivities of crystalline pentachlortoluene made at l.f. and at optical frequencies showed this material to be strongly anisotropic. A.

537.226.3

211. Dielectric relaxation in *d*-camphor. J. G. POWLES. Letter in *J. chem. Phys.*, **20,** 1648–9 (*Oct.*, 1952).

Measurement of ε' and ε'' at 9330 Mc/s for *d*-camphor from −60°C to 120°C indicate relaxation above the transition at −30°C with a critical frequency $7{\cdot}9\times10^9$ c/s at 40°C and an activation energy of 3·2 kcal/mole. D. H. WHIFFEN

ELECTRIC CONDUCTION . CURRENTS 537.3

537.3 : 537.533 : 538.551.25 : 621.38 : 621.392.52

212. A note on the approach of narrow band noise after a nonlinear device to a normal probability density. G. R. ARTHUR. *J. appl. Phys.*, **23,** 1143–4 (*Oct.*, 1952).

The output of a low-pass filter preceded by a nonlinear device excited by a noise source is given in terms of an integral equation. The first three central moments of the probability density of the output signal are obtained from the integral equation and the approach of these moments to those of a Gaussian or normal density is demonstrated. A.

537.311.1

213. The mechanism of resistance changes in a magnetic field. A. NEDOLUHA AND K. M. KOCH. *Z. Phys.*, **132,** *No.* 5, 608–20 (1952) *In German.*

Shows that the two-band model used in theoretical treatments of conduction phenomena in metals is formally equivalent to a "two-layer" model, each "layer" being characterized by a value of the conductivity, Hall coefficient and thickness. The formulae for resistance changes in a magnetic field and for the Hall coefficient, given by Wilson and others, are immediately derivable. The treatment is extended to the case of many "layers," which has applicability in discussing alloys. E. P. WOHLFARTH

537.311.1 : 539.234

214. Mean free paths of electrons in evaporated metal films. F. W. REYNOLDS AND G. R. STILWELL. Letter in *Phys. Rev.*, **88,** 418 (*Oct.* 15, 1952).

It is found that Cu and Ag films of thickness from 100–2000 Å may be deposited by evaporation so as to have reproducible properties or properties varying uniformly with thickness, so long as the rate of evaporation is rapid and the residual gas pressure is very low. The layers thus produced are highly crystallized and the variation of $(\rho'/\rho - 1)$, where ρ' is the film resistivity and ρ is the bulk resistivity, with both thickness and with temperature, both agree very well with theory. C. A. HOGARTH

537.311.31/.312.6

215. The minimum of electrical resistance at low temperatures. D. K. C. MACDONALD. Letter in *Phys. Rev.*, **88,** 148 (*Oct.* 1, 1952).

Experiments on alloys of Cu, Ag and Au, using as solute various elements which tend to occur as traces in pure samples of the parent. Previous attempts to explain the minimum phenomenon appear inadequate in the light of the results. E. H. SONDHEIMER

537.311.31

216. Radiation damage and recovery in Cu, Ag, Au, Ni, and Ta. J. W. MARX, H. G. COOPER AND J. W. HENDERSON. *Phys. Rev.*, **88,** 106–12 (*Oct.* 1, 1952).

The electric resistivity changes induced by 12 MeV deuteron bombardment of foils were determined as functions of the integrated flux. Bombardments were carried out at about −140°C and −150°C, and differences in the two sets of measurements were traced to a thermal recovery process which was proceeding with measurable velocity even at −165°C. This low temperature reaction was characterized by an activation energy of $0{\cdot}2 \pm 0{\cdot}05$ eV for Cu, Ag and Au, and one of $0{\cdot}3 \pm 0{\cdot}1$ eV for Ni and Ta. It is suggested that the migration of vacancy pairs offers a reasonable model for the initial recovery process, although other mechanisms are also discussed. A.

537.311.31

217. Residual resistance in dilute copper alloys. D. K. C. MACDONALD AND W. B. PEARSON. Letter in *Phys. Rev.*, **88,** 149 (*Oct.* 1, 1952).

Results are given for alloys with Ni, Ag, Sn and C + Sn. In some cases the resistance is much lower than that found by Linde (1932); it is suggested that elimination of oxygen contamination accounts for this. Wide deviations from Matthiessen's rule may occur. Tentative theoretical ideas are put forward. E. H. SONDHEIMER

537.311.33

218. The electrical conductivity of thin films of Pt covered with an evaporated dielectric layer. C. FELDMAN AND B. VODAR. *C.R. Acad. Sci.* [*Paris*] **235,** 414–17 (*Aug.* 11, 1952) *In French.*

The relation between resistance and temperature for thin metallic layers, $R = R_0 T^{-n} \cdot \exp[(\theta - \theta' F^{\frac{1}{2}})/T]$ [Abstr. 2118 (1948)] is verified for these layers. The action of the covering layer (of SiO_2 or ZnS, 1000 Å thick) is to increase the temperature coefficient θ, and to decrease the coefficient θ' of the applied field F. D. G. AVERY

537.311.33

219. On the distribution of transistor action. T. H. TØNNESEN. Letter in *Proc. Phys. Soc.* [*London*] *B*, **65**, 737–9 (*Sept.*, 1952).

A large number of natural mineral crystals was examined, and it was found that with eleven different materials small voltage gains were observed when extremely small specimens, produced by an ingenious grinding method, were connected as filamentary transistors. C. A. HOGARTH

537.311.33

220. Mechanism of conductivity in semiconducting phosphors. J. E. ROSENTHAL AND A. BRAMLEY. Letter in *J. chem. Phys.*, **20**, 1496 (*Sept.*, 1952).

Powdered samples of $ZnBeSiO_4$: Mn, made semiconducting by heating in CH_4, were subjected to the action of (*a*) gas glow discharge, (*b*) u.v. radiation, and (*c*) electron bombardment, the wavelength distribution of the emitted radiation being determined in each case. The results indicate the semiconductivity to be a surface phenomenon. G. I. W. LLEWELYN

537.311.33

221. Mobility of electrons in germanium. P. P. DEBYE AND E. M. CONWELL. Letter in *Phys. Rev.*, **87**, 1131 (*Sept.* 15, 1952).

Hall coefficient and conductivity measurements on *n*-type Ge at room temperatures have yielded mobility values which are higher than those previously obtained, and therefore substantially in agreement with corresponding drift mobilities. A curve of mobility *v.* resistivity was compared with theory, a good fit being obtainable if the effective mass of the electrons is taken as $\frac{1}{4} \times$ electron mass. P. T. LANDSBERG

537.311.33

222. On the electrical properties of porous semiconductors. E. B. HENSLEY. *J. appl. Phys.*, **23**, 1122–9 (*Oct.*, 1952).

It has been proposed that the conductivity of a porous semiconductor, such as oxide-coated cathode, may be influenced by the presence of an electron gas in the pores of the aggregate. Calculations for the magnitude of this component of the conductivity are made on the basis of two simplified models approximating the geometry of a pore. The conditions under which such a component of the conductivity can appreciably modify the total conductivity are analysed. It is further shown that such a porous semiconductor will possess two sources of thermoelectric e.m.f. A simple theory for the thermoelectric power of the electron gas in a pore is developed, and the manner in which it will combine with the normal thermoelectric power of the crystals is shown. A.

537.311.33

223. Activation energy of heat treatment introduced lattice defects in germanium. R. M. BAUM AND C. S. HUNG. Letter in *Phys. Rev.*, **88**, 134 (*Oct.* 1, 1952).

Hall coefficient and resistivity were measured in heat-treated Ge single crystals between 25°K and 200°K. The activation energy of thermally introduced acceptors was calculated from the experimental results to be 0·047 or 0·058 eV. The authors point out, however, that the analysis of low-temperature experimental data is at present unreliable.

P. T. LANDSBERG

537.311.33

224. Electrical conductivity and structure of sputtered cadmium oxide layers. G. HELWIG. *Z. Phys.*, **132**, *No.* 5, 621–42 (1952) *In German.*

By means of sputtering a Cd cathode at a low pressure of oxygen it is possible to prepare reproducible thin films of CdO having a high electrical conductivity and optical transmission, of good mechanical strength, and having a density slightly less than the X-ray density for CdO. The variation of the control parameters and the effects on the properties of the layers produced is investigated and the chemical reactions taking place in the layers are discussed. C. A. HOGARTH

537.311.33 : 537.32 : 537.58

225. Electrical conductivity and thermoelectric power of (BaSr)O and BaO. J. R. YOUNG. *J. appl. Phys.*, **23**, 1129–38 (*Oct.*, 1952).

A study has been made at different states of activation and on different base metals over a temperature range of 1100°K to 300°K. A plot of the logarithm of the conductivity *v.* reciprocal temperature showed two straight line regions. The temperature dependence of the thermionic emission was found to be the same as the temperature dependence of the conductivity in the temperature range 700°K to 1100°K. The slope of a plot of the thermoelectric power *v.* reciprocal temperature was also similar to the thermionic work function and the conductivity activation energy in this temperature range. The thermoelectric power varied with temperature from a value of about 2·0 mV/° at 1100°K, increasing to about 2·5 mV/° at 800°K, reducing to between 1·0 and 0·5 mV/° at about 500°K, and remaining practically constant or increasing slowly at still lower temperatures. In all thermoelectric power measurements the hot junction was positive indicating negative charge carriers. The simple semiconductor theory does not adequately account for these results which seem to be in good agreement with the pore conduction hypothesis. A.

537.311.33 : 538.632

226. The conductivity and Hall coefficient of sintered lead sulphide. E. H. PUTLEY. Letter in *Proc. Phys. Soc.* [*London*] *B*, **65**, 736–7 (*Sept.*, 1952).

Experiments are described and compared with previous measurements on single crystals of PbS in an attempt to assess the importance of intergranular contacts when interpreting results for electrical properties of polycrystalline specimens in terms of theory developed for a single crystal semiconductor. It is found that the Hall coefficient varies over the temperature range 77 to 800°K in much the same manner as for a single crystal of comparable purity, but that the resistivity values below, say, 300°K may be considerably in error. C. A. HOGARTH

537.311.33 : 538.632 : 536.48

227. Interpretation of the low temperature Hall curve of a degenerate germanium sample. D. M. FINLAYSON, V. A. JOHNSON AND F. M. SHIPLEY. Letter in *Phys. Rev.*, **87**, 1141 (*Sept.* 15, 1952).

Low temperature Hall coefficient and resistivity measurements on an *n*-type antimony-doped single crystal of germanium are reported. The Hall coefficient exhibits a maximum near 120°K, and it is

shown that this is consistent with a decrease of carrier densities from $2{\cdot}15\times10^{18}$ at 120°K to $1{\cdot}42\times10^{18}$ at 10°K. The donor levels appear to lie 0·005 eV above the bottom of the conduction band. P. T. LANDSBERG

537.311.33

228. The relaxation phenomena of the selenium rectifier. T. NUMATA, Y. MATUKURA AND A. OKAZAKI. *Mem. Fac. Sci. Kyūsyū Univ. B*, **1**, *No.* 1, 22–5 (1951).

Relaxation phenomena, i.e. changes in current with time when a low field (0·1 to 0·5 volt) is applied after the previous application of a much higher field, are studied and the results found to be similar in form to those for the Cu_2O rectifier. Relaxation times τ are found to lie in the range 100–700 sec; $\log\tau$ varies as $1/T$; the phenomena are discussed and related to ionization processes in the semiconductor. C. A. HOGARTH

537.311.33

229. *p–n* junctions produced by growth rate variation. R. N. HALL. Letter in *Phys. Rev.*, **88**, 139 (*Oct.* 1, 1952).

By varying the growth rate of Ge crystals from a melt containing definite amounts of *n*- and *p*-impurities of different segregation coefficient it is possible to produce in some cases more than a hundred uniformly spaced *p–n* junctions in any one crystal. By this means very sharp gradients may be produced and the junctions are of low barrier capacity and high Zener breakdown voltage. C. A. HOGARTH

537.311.33

230. The temperature dependence of the current flow in germanium *p–n* junctions. D. GEIST AND K. SEILER. Note in *Naturwissenschaften*, **39**, *No.* 17, 401 (1952) *In German.*

Voltage-current characteristics for *p–n* junctions are measured at 60°C, 27°C and −70°C. The saturation reverse current is found to be strongly dependent on temperature as predicted by theory, but the Zener breakdown region of the curve is practically independent of temperature, as is the actual applied voltage at which this breakdown occurs. C. A. HOGARTH

537.311.35

231. Conductance in non-aqueous solutions. R. C. SCHONEBAUM. Letter in *Nature* [*London*] **170**, 422–3 (*Sept.* 6, 1952).

Fuoss and Kraus (1933) concluded from the conductivities of solutions in media of widely divergent properties that, viscosity excepted, there is no specific influence due to the solvent, but that the dielectric constant of the medium alone determines conductivity data. Fuos and Kraus did not consider acid media, but the conductivities of solutions of tetramethylammonium picrate in glacial acetic and propionic acids respectively over a wide range of concentrations are now shown to support the above conclusion. Data curves and 4 refs. are included. H. H. HODGSON

537.312.5 : 535.343.2

232. Photoelectric emission associated with β-band absorption in alkali iodides. E. TAFT AND L. APKER. Letter in *J. chem. Phys.*, **20**, 1648 (*Oct.*, 1952).

The optical absorption called β-band in KI crystals [see Abstr. 5272 (1951)] is assumed to result from an exciton trapped at an *F*-centre (or hole trapped at an *F'*-centre) the total energy then exceeding that of the electron at rest in free space. This would thus give photoelectric emission, which is experimentally verified. G. F. J. GARLICK

537.312.5

233. Photoconduction in anodic Ta_2O_5. L. APKER AND E. A. TAFT. *Phys. Rev.*, **88**, 58–9 (*Oct.* 1, 1952).

Interference phenomena in films of anodic Ta_2O_5 show that fundamental optical absorption occurs for $h\nu > 4{\cdot}6$ eV. The resultant photoconduction between electrolyte and tantalum substrate shows a quantum yield near 0·5 when the field in the film is of order 10^7 volts/cm. A.

537.312.5

234. Photoconductivity in the elements. T. S. Moss. *London, Butterworths Scientific Publications* (1952) 263 *pp.*

The book is in two parts, Pt I dealing with theoretical aspects of photoconductivity and Pt II with photoconductivity and related effects in the elements. Pt I considers the energy band model for semiconductors, types of semiconductor, theory of conductivity and the Hall effect, the optical properties of materials, such as absorption by crystal lattices and by conduction electrons, refractive index theory, relation between optical and thermal activation energies of semi-conductors, primary and secondary photocurrents, spectral response, the theory of photoconductivity and photovoltaic effects, the temperature dependence of spectral responses, relation between limiting wavelength for photoconductivity and refractive index, and finally photoemissive effects in semiconductors. In Pt II the optical and electrical characteristics of the elements B, diamond, Si, Ge, grey Sn, P, As, Sb, S, Se, Te and I are considered. Many references are given and adequate subject and author indices are included. G. F. J. GARLICK

537.312.6

235. On the emission of sound waves from an electron in a metal and the theory of superconductivity. O. KLEIN. *Ark. Fys.*, **5**, *Paper* 22, 459–69 (1952).

Detailed calculations to Abstr. 5124 (1952). The probability for the emission of a phonon by an electron is calculated from Bloch's theory and it is shown that the condition for superconductivity proposed in the previous paper is only fulfilled if one assumes that a small fraction of the electron density remains stationary during the lattice vibrations. H. LONDON

537.312.62

236. Field emission from tantalum in the normal and superconducting state. R. GOMER AND J. K. HULM. Letter in *J. chem. Phys.*, **20**, 1500–2 (*Sept.*, 1952).

No difference greater than 0·2% was found in the field emission of normal and superconducting tantalum. It is concluded that when a metal becomes superconducting any changes of the potential barrier and of the chemical potential of the conduction electrons cannot greatly exceed kT_c where T_c is the transition temperature. D. SHOENBERG

537.312.62

237. Size effects in the superconductivity of cadmium, M. C. Steele and R. A. Hein. Letter in *Phys. Rev.*, **87,** 908 (*Sept.* 1, 1952).

From the increase in magnetic threshold value with decreasing particle size a zero point penetration depth of $\sim 10^{-4}$cm is estimated. H. LONDON

537.312.62

238. Similarity properties of the two-fluid model of superconductivity. E. Maxwell. Letter in *Phys. Rev.*, **87,** 1126–7 (*Sept.* 15, 1952).

As the normal specific heat is mass-independent a single mass-dependent parameter governs the thermodynamic functions of isotopes. H. LONDON

537.312.62

239. Superconductivity below 1°K. M. C. Steele. Letter in *Phys. Rev.*, **87,** 1137–8 (*Sept.* 15, 1952).

Straightforward thermo-magnetic considerations explain the positive $\partial I/\partial H$ (I magnetic moment of a superconductor, H magnetic field strength) found by Daunt and Heer [Abstr. 1769 (1950)] when warming up superconductors in a magnetic field. H. LONDON

537.312.62

240. Superconductivity of rhenium. J. G. Daunt and T. S. Smith. *Phys. Rev.*, **88,** 309–11 (*Oct.* 15, 1952).

Measurements have been made in the liquid helium temperature region of the magnetic threshold curve of rhenium by observations of the magnetic moment of a powdered sample. The transition temperature T_c in zero magnetic field was found to be 2·42°K, and the observed slope of the threshold curve at $T = T_c$ was 235 gauss per degree. Assuming a reversible transition, the value of the normal electronic specific heat coefficient γ obtained from the magnetic data is $4{\cdot}6 \times 10^{-4}$ calories per mole per degree^2, a value which would be expected from the correlation between γ/V and T_c previously proposed. A.

537.312.62

241. The superconductive transition in tantalum. H. Preston-Thomas. *Phys. Rev.*, **88,** 325–7 (*Oct.* 15, 1952).

The construction of small coreless coils allows the simultaneous measurement of resistive and magnetic transitions in tantalum. As is the case with the other "hard" superconductors, these measurements give evidence of the presence of "filaments" in the metal. The results are explained on the basis of a modification of a two-phase model used previously, and critical field-temperature curves are derived for the bulk metal and for the filament material. A.

537.312.62

242. The free energies and phase transition of a cylindrical superconductor. P. M. Marcus. *Phys. Rev.*, **88,** 373–81 (*Oct.* 15, 1952).

The Helmholtz and Gibbs free energies for a cylindrical superconductor of arbitrary cross-section in a uniform axial magnetic field are defined carefully in terms of magnetic moment or total flux for the body as a whole. These definitions, applicable for arbitrary electrodynamic description of the superconductor, are transformed to equivalent forms with different density functions, on assuming the London equations. A general expression is obtained for change of Gibbs function when the superconducting cross-section contracts and normal phase appears, which gives directly the critical current density condition of London for the phase transition. Three critical fields are defined and compared, making use of several theorems on the dependence of the boundary current density on the shape and size of the cross-section. The general formulae for free energies and critical fields are illustrated for several special cross-sections, including an oval shape with non-uniform boundary current density. The metastability of a superconductor described by the London equations is illustrated and discussed. A.

537.312.9

243. The extra electrical resistance due to cold work and neutron irradiation of platinum. R. A. Dugdale. Note in *Phil. Mag.*, **43,** 912–14 (*Aug.*, 1952).

By annealing Pt specimens at differing temperatures (70 and 90°c) for several days, thereby decreasing the additional resistance caused by the previous treatment, an activation energy for the annealing process of 1·19–1·20 eV is obtained for both cold worked and neutron-bombarded material. This suggests that the same processes are responsible for the additional resistance in the two cases and supports Seitz's speculation concerning the removal of lattice vacancies during annealing. C. A. HOGARTH

537.323

244. Thermo-electric measurements on *p*-type silicon. J. Savornin and F. Savornin. *C.R. Acad. Sci.* [*Paris*] **235,** 465–7 (*Aug.* 18, 1952) *In French.*

Measurements on impure Si specimens giving values as high as 700 μV/°C are reported.

C. A. HOGARTH

ELECTRIC DISCHARGES 537.52

537.523/.527

245. Secondary processes active in the electrical breakdown of gases. L. B. Loeb. *Brit. J. appl. Phys.*, **3,** 341–9 (*Nov.*, 1952).

Recent advances in techniques and consequent results indicate the complexity of gaseous breakdown mechanisms. The three cathode mechanisms and two anode mechanisms are carefully analysed indicating their relative importance and conditions of appearance. They are shown to lead to the same type of generalized breakdown threshold condition with statistical fluctuations and subject to alteration by space charges. This condition masks the processes active, rendering analysis difficult. The threshold mechanisms alone do not determine the breakdown, for this involves the ultimate resulting discharge. The factors modifying the discharge are gas type and state, electrodes, geometrical factors and external circuit constants. The discharge types to which these lead and governing circumstances are presented. In conclusion, proper modern methods of discharge analysis are indicated. 49 refs. A.

537.523./527

246. Electrical discharges in gases. F. LLEWELLYN JONES. *Nature* [*London*] **170,** 601–3 (*Oct.* 11, 1952).

Report of a session of Section A of the British Association, Belfast, September, 1952.

537.523.3

247. Pulse-free discharges in negative point-to-plane corona. A. GREENWOOD. *Phys. Rev.*, **88,** 91–2 (*Oct.* 1, 1952).

Near breakdown the negative point-to-plane corona discharge has been observed to adopt a pulse-free mode. The physical characteristics of this phase are described, but no attempt is made to explain the transition from the pulsating discharge. A.

537.525

248. Failure of vacuum insulation at low field strengths. D. S. CLIFFORD, R. L. FORTESCUE AND J. ROBERTS. Letter in *Nature* [*London*] **170,** 503 (*Sept.* 20, 1952).

A new form of breakdown between electrodes *in vacuo* is described. If the electrodes are not subjected to heat treatment and a voltage between 10–150 kV is applied, self extinguishing bursts of current are observed which are (*a*) critically dependent on anode conditions, and (*b*) very nearly independent of field strength. A. H. W. BECK

537.525 : 621.3.015.5

249. Electrical breakdown in vacuum. D. LEADER. *Instn Elect. Engrs Paper* 1410, 3 *pp.* (1953).

Direct and impulse voltages were applied to an electrode system in a vacuum of the order of 10^{-5} mm Hg. Of particular interest were the results obtained with a needle-and-sphere system, the breakdown voltage of which was considerably higher than that of a normal sphere-gap with the same electrode spacing, especially when a very fine needle was used. Oscillograms were taken of the current during a breakdown in vacuum, and of the collapse of voltage across the gap. With the fastest time-sweep available the current rise and voltage collapse were found to take place in 0·1 μsec. A longer sweep demonstrated that there is a minimum stable current below which a continuous breakdown will not occur; if circuit conditions limit the current to below this value, it will flow only intermittently. This may account for the difficulty experienced by some workers in making measurements of breakdown in vacuum with direct voltages. A.

537.525.4

250. On the radiation emitted, in various wavelength ranges, by condensed discharges in xenon and krypton. R. LEGROS. *Bull. Soc. Franç. Elect.* (*Sér.* 7) **2,** 443–6 (*Aug.*, 1952) *In French.*

Gives detailed results of measurements made on discharges in the pressure range 10–200 mm Hg for discharge capacitances varying from 20 to 90 μF (0·6 to 2 kV). Filters, whose transmission characteristics are shown graphically, were used to isolate radiation in the following wavelength ranges: $0{\cdot}32 < \lambda < 2{\cdot}6\,\mu$; $0{\cdot}32 < \lambda < 0{\cdot}42\,\mu$; $0{\cdot}42 < \lambda < 0{\cdot}68\,\mu$; $0{\cdot}68 < \lambda < 0{\cdot}82\,\mu$ and $0{\cdot}82 < \lambda < 2{\cdot}6\,\mu$. J. D. CRAGGS

537.525.4

251. Shock waves in low pressure spark discharges. R. G. FOWLER, W. R. ATKINSON, W. D. COMPTON AND R. J. LEE. Letter in *Phys. Rev.*, **88,** 137 (*Oct.* 1, 1952).

Describes, with a photograph, self-luminous shock waves in low pressure transient discharges. Observed and calculated shock wave velocities are compared for a series of discharges in argon and various other relevant calculations of temperatures and pressures, etc., are tabulated. The shock waves were initiated by means of condensed spark discharges. J. D. CRAGGS

537.525.4

252. High frequency breakdown in neon. A. D. MACDONALD. Letter in *Phys. Rev.*, **88,** 420 (*Oct.* 15, 1952).

Reports measurements of breakdown fields in cylindrical cavities at 3000 Mc/s in pure neon for pressures ranging from 0·5 to 300 mm Hg. Satisfactory agreement with theory is obtained. J. D. CRAGGS

537.525.8

253. Comparison of electron density in different regions of a d.c. glow discharge. B. J. UDELSON AND J. E. CREEDON. Letter in *Phys. Rev.*, **88,** 145 (*Oct.* 1, 1952).

By moving a discharge tube through a suitable cavity (2962 Mc/s) relative measurements of electron density, at different points along the positive column and in the Faraday dark space, could be made. The glow discharge was in hydrogen at 14 mm Hg pressure, with 1 mA current. Some results are exhibited graphically. J. D. CRAGGS

537.525.8 : 537.525.72

254. Radio frequency oscillations in a.c. silent discharges. S. R. KHASTGIR AND P. S. V. SETTY. Letter in *Curr. Sci.*, **21,** 197–8 (*July*, 1952).

Describes expts. on the detection of h.f. oscillations (1·25–15 Mc/s) in ozoniser corona discharges. J. D. CRAGGS

537.525.8 : 538.561

255. On the plasma-like oscillation. T. NISHIYAMA. Letter in *Progr. theor. Phys.*, **6,** 1025–6 (*Nov.–Dec.*, 1951).

A brief note on theoretical studies of plasma oscillation frequencies, and related to earlier work by the author and by Pines and Bohm. J. D. CRAGGS

537.527.3

256. Characteristics of the point-to-plane corona discharges in air at high pressures. I. NONAKA, S. MORITA, K. TAKESITA, N. KAWAI, T. ISHIMATSU, S. SUEMATSU AND C. TAKEI. *Mem. Fac. Sci. Kyūsyū Univ. B,* **1,** *No.* 2, 37–42 (1952).

The voltage-current characteristics and the spreads of discharges from point electrodes in point-to-plane corona were measured in air at pressures from 1 to 8 absolute atomospheric pressure for pos. and neg. signs of the point electrode. The point-to-plane distances used were 10, 15 and 20 mm. The results will be useful for the design of Van de Graaff electrostatic generators of pressure type. A.

537.527.5

257. The arc form of high pressure discharges in the noble gases. K. Larché. *Z. Phys.*, **132**, *No.* 5, 544–52 (1952) *In German.*

Gives photographic details, with discussion, of discharges at pressures ~ 10 atmospheres notably in xenon. The influence of electrode disposition (convection losses, etc.) is described, in relation to discharge structure and stability. The luminous efficiencies of various discharges were also measured. J. D. CRAGGS

X-RAYS 537.531

537.531

258. The spectral distribution of radiation from X-ray tubes. J. R. Greening. Letter in *J. Opt. Soc. Amer.*, **42**, 685–6 (*Sept.*, 1952).

Criticizing Greenfield *et al.* [Abstr. 2729 (1952)] in use of Laplace transforms to derive spectrum from transmission curve, and indicating advantages of graphical method. F. T. FARMER

537.531 : 537.533.72

259. Intensity limitations in a point source of X-rays. V. E. Cosslett. *Proc. Phys. Soc.* [*London*] *B*, **65**, 782–5 (*Oct.*, 1952).

When the diameter of the focal spot of electrons on an X-ray target is reduced to the order of a micron, the conditions of heat dissipation become so favourable that a greatly increased specific loading is possible. The use of an electron lens to obtain such a small spot introduces a limitation on the rate of supply of energy, as its high spherical aberration requires insertion of a very small aperture, the size of which must be reduced *pari passu* with the size of spot desired. For magnetic lenses of usual design the rate of energy supply is then proportional to the radius of the spot. Comparison with the rate of heat dissipation shows that, for spots of the order of a micron, the limitation on X-ray intensity is not the thermal properties of the target, as in tubes with large focus, but the emission obtainable from the cathode. Specific loadings of the order of 10^7 W cm^{-2} can be tolerated in a spot of 1 micron; the corresponding emission current density would be of the order of 100 amp cm^{-2}. A.

CATHODE RAYS . POSITIVE RAYS 537.533/.534

537.533.72

260. Measurement of the 1st and 2nd derivatives of the axial induction in a strong magnetic lens. P. Gautier. *C.R. Acad. Sci.* [*Paris*] **235**, 361–4 (*Aug.* 4, 1952) *In French.*

A small coil is mounted coaxially with the lens and is arranged to vibrate sinusoidally parallel to the lens axis. The e.m.f. gives immediately the first derivative. Two identical coils mounted in the same way and very close together are connected in opposition to give the second derivative. A. H. W. BECK

537.533.72

261. The optimum space-charge-controlled focus of an electron beam. D. L. Hollway. *Austral. J. sci. Res. A*, **5**, 430–6 (*Sept.*, 1952).

The problem of space-sharge defocusing of circular electron beams is considered, and expressions for the condition of optimum focus are derived from the equations of the beam profile. It is shown that, over a wide range of spot radii, the optimum-focus expressions may be replaced by much simpler relationships suited to electron-beam design problems. A.

537.533.72

262. The formation of the diffraction image with electrons in the Gabor diffraction microscope. M. E. Haine and T. Mulvey. *J. Opt. Soc. Amer.*, **42**, 763–73 (*Oct.*, 1952).

The projection and transmission methods are discussed in relation to their practical application. The significance of the two methods as limiting cases of one general method is shown. Analysis shows that the projection method is limited in a practical sense by the combination of a chromatic variation in magnification and path difference. This effect leads either to a severely limited field or a much more stringent electrical stability requirement. Analysis of the transmission method shows it to be free from the above effect, besides having other practical advantages. Some initial results of the application of this method are shown. A.

537.533.74

263. On the accuracy of the Molière function. II. J. Nishimura and K. Kamata. Letter in *Progr. theor. Phys.*, **6**, 628–30 (*July–Aug.*, 1951).

For Pt I, see Abstr. 8774 (1951). The formula for the lateral distribution function given in Pt I is evaluated numerically and compared with Molière's results. E. P. GEORGE

537.533.74

264. The Coulomb scattering of relativistic electrons and positrons by nuclei. H. Feshbach. *Phys. Rev.*, **88**, 295–7 (*Oct.* 15, 1952).

The Mott series for the Coulomb scattering of electrons and positrons of high energy is summed numerically for angles varying from 30° to 150° and for nuclear charge varying from 13 to 80. A.

537.533.74

265. The backscattering of positrons and electrons. H. H. Seliger. *Phys. Rev.*, **88**, 408–12 (*Oct.* 15, 1952).

β-Rays from a point source, backscattered by materials of various atomic numbers Z have been collected over a 2π solid angle and also over narrow solid angles at various obliquities. In all cases electrons are backscattered to a greater extent than positrons. The number and energy spectrum of the backscattered β-rays depend strongly on the direction of emergence and on Z. In spite of the use of heteroenergetic sources, the results can be interpreted qualitatively on the basis of multiple scattering, in terms of a "side-scattered" and a "diffused" component. A.

537.533.79

266. Shadow of an electron beam. H. M. Smith and S. Hansen. *J. appl. Phys.*, **23**, 1054–5 (*Sept.*, 1952).

A shadow is produced on the fluorescent screen of a cathode-ray tube by a focused electron beam which passes obliquely across a "flood" beam. It is suggested that the shadow arises from the deflection of the low velocity "flood" electrons by the space-charge field of the focused beam. J. THEWLIS

537.533.8

267. The theory of secondary emission. J. F. Marshall. Letter in *Phys. Rev.*, **88**, 416 (*Oct.* 15, 1952).

Examines the theory of the interactions between incident electrons and the weakly bound lattice electrons in a solid. Contrary to previous conclusions, it is found that the rate of production of secondaries depends on the energy of incident electrons.

F. LLEWELLYN JONES

537.533.9

268. On the radiation emitted by electrons in uniform motion. F. A. Fuertes. *Univ. Nac. Tucuman Publ. No.* 465, 20 *pp.* (1949) *In Spanish.*

Simple considerations on the Cherenkov radiation.

L. PINCHERLE

537.534.72

269. Proposed method for producing short intense monoenergetic ion pulses. R. C. Mobley. *Phys. Rev.*, **88**, 360–1 (*Oct.* 15, 1952).

A method is outlined whereby suitable periodic deflection over the range of possible path lengths between foci of an appropriate focusing magnet is utilized to convert a continuous monoenergetic ion beam at one focus into very short duration high intensity monoenergetic ion pulses at the other focus. Time-of-flight analysis of reaction particle pulses resulting from the interaction of the ion pulses with stationary target nuclei is discussed and the application of this method to the elastic and inelastic scattering of neutrons is considered briefly. A.

537.534.72 : 551.508.1

Radiofrequency mass spectrometer for upper air research. *See Abstr.* 558

537.534.74

270. The university of Pittsburgh scattering project. R. S. Bender, E. M. Reilley, A. J. Allen, R. Ely, J. S. Arthur and H. J. Hausman. *Rev. sci. Instrum.*, **23**, 542–7 (*Oct.*, 1952).

A scattering programme at the University of Pittsburgh uses charged particles from the cyclotron (8 MeV protons, 16 MeV deuterons and 32 MeV α-particles). An electromagnet focuses the cyclotron beam through an aperture in an 8 ft shielding wall into a scattering laboratory; a second magnet analyses the beam in energy; a third magnet analyses the energy of the charged particles produced in the reaction. For $\frac{1}{16}$ in. analysing slits $1{\cdot}0\,\mu$A of $8 \pm 0{\cdot}010$ MeV protons are available at the target 31 ft distant from the cyclotron. The reaction particle analyser can be rotated about the target. The energy dispersion for 5·298 MeV α-particles is 0·192 MeV/in. for each analyser; the momentum resolution is 1 part in 850. The detector is a scintillation counter. The energy determinations at present stage of development are thought to be accurate to $\pm 0{\cdot}2\%$ ascribed to magnet calibration uncertainties. Energies above and below this value are thought to be of the same precision but the actual calibrations have not been completed. A.

537.534.74

271. Multiple scattering of fast protons in photographic emulsions. M. J. Berger. *Phys. Rev.*, **88**, 59–70 (*Oct.* 1, 1952).

Measurements have been made of the multiple Coulomb scattering of protons with energies of 337 ± 1 MeV and 218 ± 2 MeV in Ilford G-5 emulsions. A total of 261 tracks with a combined length of 130·4 cm were analysed by the determination of the lateral multiple scattering deflections according to the "co-ordinate method." The results are summarized in terms of the customary scattering factors which, for a given cell length, indicate the proportionality of the average multiple scattering deflection to the quantity "charge/momentum × velocity" of the scattered particle. Scattering factors are given for cell lengths of 250, 500, 750 and 1000 microns. These results are compared with the predictions of various theories of multiple scattering, including those of Moliere, Snyder and Scott, as well as a proposed extension of the theory of Goudsmit and Saunderson, which has the advantage of being directly and conveniently applicable to the analysis of lateral multiple scattering deflections. The predicted theoretical scattering factors are in fair agreement with the experimental values, but slightly larger; the discrepancies are either within, or just outside of, the limits of the experimental error (3–6%). A.

537.534.74

272. Differential cross-section measurements for the scattering of protons by deuterons. R. J. S. Brown, G. D. Freier, H. D. Holmgren, W. R. Stratton and J. L. Yarnell. *Phys. Rev.*, **88**, 253–6 (*Oct.* 15, 1952).

The differential cross-section for protons elastically scattered by an incident deuteron beam has been measured in the energy range 0·96 MeV to 3·22 MeV. This corresponds to an extension of previous p–d scattering data down to an energy of 0·48 MeV incident proton energy. The angular range in the c.m. system of co-ordinates is from 67° to 126° with the cross-section showing characteristic minima in the neighbourhood of 90° at each energy considered. Values of the cross-section vary from 0·147 to $0{\cdot}280 \times 10^{-24}$ cm^2 over this range of parameters. A.

537.534.74 : 539.172.13

273. The scattering of 31·5-MeV protons from several elements. R. Britten. *Phys. Rev.*, **88**, 283–94 (*Oct.* 15, 1952).

The elastic and inelastic scattering of 31·5 MeV protons from the Berkeley linear accelerator from Be, C, Al, Pb and Pt have been observed, using a sodium iodide (Tl) crystal and photomultiplier for particle detection and energy measurement. Inelastic scattering led to the excitation of states or closely spaced groups of states at 2·5, 6·8 and 11·6 MeV in beryllium; 4·3, (7·5) and 9·5 in carbon; and a group of states between 11 and 17 in carbon. Deuterons have been observed from the reaction $C^{12}(p, d)C^{11}$,

leading to the ground state of C^{11}. Differential cross-sections have been measured for all these reactions at two or three angles. The differential cross-sections for the elastic scattering of 31·5 MeV protons have been measured at several angles for Be^9, C^{12}, Al^{27} and Pb. A comparison with the results of calculations based on several different nuclear models is made. The extreme sensitivity of the calculated cross-sections (in the backward hemisphere) to the individual phase shifts and amplitudes indicates that moderately rough measurements of the backward scattering cross-sections of nuclei for neutrons in this energy range would give accurate determinations of the individual phase shifts. A.

537.534.74 : 539.172.13

Coulomb scattering of deuterons. *See Abstr.* 437

537.534.74 : 539.172.13

Elastic scattering of deuterons by tritons. *See Abstr.* 438

537.534.75

274. Evaluation of range straggling for heavy particles. D. O. Caldwell. *Phys. Rev.*, **88**, 131–2 (*Oct.* 1, 1952).

From the formula developed by Lewis for the differential range distribution of heavy, charged, non-relativistic particles, an integral range distribution is obtained. The latter is evaluated for 2 to 500 MeV protons in Al to show, in a practical way, how the distribution differs from a Gaussian, as evidenced by its shorter-than-average range tail. The extent to which this tail increases the mean range and makes it different from the most probable range is indicated. Values for the range straggling are also given. A.

DISCHARGE TUBES . COUNTERS 537.54

537.542

275. Gaseous contamination of Geiger–Müller counters. D. Keefe, T. E. Nevin, C. B. A. McCusker and N. A. Porter. Letter in *Nature* [*London*] **170**, 501–2 (*Sept.* 20, 1952).

Argon–alcohol (10 cm–2 cm) was used as a filling, and air or CO was added in stages. The effect on plateau slope at first was linear. The plateau disappeared at 1 cm air or 1 mm CO. F. R. Holt

537.542 : 389.6 : 621.387.42.001.4

276. Standards on gas-filled radiation counter tubes: methods of testing, 1952. *Proc. Inst. Radio Engrs*, **40**, 926–30 (*Aug.*, 1952).

537.542

277. A new method of using ionization chambers. W. D. Parkinson and V. F. Hess. Letter in *Rev. sci. Instrum.*, **23**, 565–6 (*Oct.*, 1952).

This note describes a new way of arranging the guard ring in an ionization chamber, which results in decreased sensitivity to changes in the collector electrode capacitance to the walls. Chamber wall thickness of $4{\cdot}5\times10^{-3}$ g/cm^2 has thus become practicable even in the field where winds normally affect the operation of chambers with large thin walls. J. D. Craggs

537.542

278. Discrimination against noise in scintillation counters. R. J. T. Herbert. *Nucleonics*, **10**, 37–9 (*Aug.*, 1952).

The method of discrimination described can be applied in the case of phosphors having a suitable decay time. Scheelite with a decay time of 8 μsec was used. The amplified pulses from the photomultiplier were about 0·5 μsec wide, so that a single fast electron in the phosphor produced a group of pulses. The first pulse in a group opened a gate after 3 μsec, which remained open for about 25 μsec. Provided that the second pulse in the group followed during this period a count would be recorded by the scaler. With a Scheelite phosphor the probability of this happening was found to be 65%, so that only 35% of the pulses were lost. Randomly occurring noise pulses, on the other hand, were reduced by a very large factor. L. R. Shepherd

537.542

279. Liquid scintillation counters. C. E. Falk and H. L. Poss. *Amer. J. Phys.*, **20**, 429–39 (*Oct.*, 1952).

A review of the present status of liquid scintillators is given. The theory explaining the properties of the counters is discussed. Preparation of counters is described and counter characteristics such as emission spectra, response to various nuclear radiations, counting efficiencies and emission intensities from various scintillating solutions are given. The applications of liquid scintillation counters in various fields of nuclear physics are discussed. A.

537.542

280. Particle localization by means of a scintillation detector. L. C. L. Yuan and H. L. Poss. *Rev. sci. Instrum.*, **23**, 553–4 (*Oct.*, 1952).

A cylindrical tube containing scintillation liquid, 8 in long, 2½ in. in dia., with flat ends, is placed between two photomultipliers. Neglecting reflection from the side walls, the intensity of light received at a photomultiplier from a scintillation is proportional to the solid angle subtended by the photocathode at the scintillation point. The ratio of two coincident pulses from the two photomultipliers will then determine the location of the scintillation along the tube independent of light intensity or particle energy. The pulse ratio was obtained by feeding one pulse to the vertical deflection plates and the other to the horizontal ones of an oscilloscope and by measuring the inclination angle of the trace. The trace amplitude is related to the particle energy dissipated in the liquid. Preliminary results on the localization effect were obtained using cosmic rays. The coincidence pulse from a Geiger counter telescope perpendicular to the scintillation detector was used to unblank the oscilloscope. Uncertainties resulting from statistical variations of the photomultipliers were measured by means of a light source placed at various distances between the photomultipliers to simulate scintillations. It appears that the localization can be feasibly determined within 6% of the length of the scintillator. A.

537.542 : 539.185

281. Neutron-detecting phosphors. J. Schenck. *Nucleonics*, **10**, 54–6 (*Aug.*, 1952).

The results of studies on over 300 lithium-containing

phosphors are outlined. A table is given, setting out the response to both u.v. and Po α-particles of a number of lithium compounds including silicates, titanates, zirconates, tungstates and stannates with various activators. $Li_2Si_2O_5(Ti)$ which had a strong response, was moulded into a ¼ in thick translucent, slab with a thermal neutron counting efficiency of 40%. The long decay time (200 μsec) of this phosphor is a serious disadvantage. The shortest decay time (0·2 μsec) was observed with $Li_2CaSiO_4(Ce)$ which also displayed a strong response to u.v. radiation and α-particles. Sn was found to be a good activator of both LiI and LiBr. A pulse height spectrum obtained by thermal neutron irradiation of a small crystal of LiI(Sn) showed an energy resolution of 15%. A large clear crystal of LiBr(Sn) showed an energy resolution of 27%. L. R. SHEPHERD

537.542

282. Fast coincidences with Čerenkov counters. Z. Bay, M. R. Cleland and F. McLernon. Letter in *Phys. Rev.*, **87**, 901–2 (*Sept.* 1, 1952).

Resolving time limitations were studied by passing high-energy electrons through a Lucite radiator and directing the light (by mirrors) to two 1P21 photomultipliers. It is concluded that time intervals can be measured to 10^{-11} sec, the limiting random fluctuations occurring mainly in the first stages of the photomultipliers. J. J. WILKINS

537.542 : 621.318.572

283. A scaler using dekatron scaling tubes. I. Nilsson. *Chalmers Tekn. Hogsk. Handl.*, *No.* 125, 8 *pp.* (1952).

A simple and inexpensive scaler to be used with self-quenching tubes is described. The input sensitivity of the apparatus is 0·25 V and its coincidence loss for random pulses is 2·5% at 1000 rising to 25% at 6000 counts per minute. The normal operation is 8000, but a speed of 20 000 c.p.m. is claimed for this scaler when fed with equally spaced rectangular pulses. Z. F. WOJNAR (R)

537.542 : 531.791 : 53.087.9

A logarithmic counting-rate recorder. *See Abstr.* 16

537.542 : 621.318.572

284. A ferromagnetic scaling circuit. C. H. Hertz. *Ark. Fys.*, **5**, *Paper* 10, 141–61 (1952).

For the counting of random pulses from a G.M. tune different kinds of scaling circuits are used between the G.M. tube and the mechanical counter. In this paper a scaling circuit using a ferromagnetic material is described. Each pulse coming from the G.M. tube triggers the discharge of a condenser through a primary coil on a small iron core, whereby a thin surface layer of it is magnetized. In a secondary coil around the iron core a voltage pulse is induced each time the condenser is discharged. The maximum voltage of this secondary pulse depends on the magnetization of the core and thus on the number of condenser discharges that have passed through the primary coil previously. This effect can be used for the construction of a scaler or certain other electronic devices. A quantitative theory of the effect is given. A.

537.542

285. Low-level counting techniques. A. J. Freedman and E. C. Anderson. *Nucleonics*, **10**, 57–9 (*Aug.*, 1952).

Equations are derived governing the relationship between changes in sample and background counting rates and the resulting changes in the statistical accuracy of the sample count obtained in a given time. The results are applied to the investigation of C^{14} in proportional counters, containing $C^{14}O_2$, when the background and sample counting sensitivities can be varied in different degrees by change of discriminator bias levels. L. R. SHEPHERD

537.542

286. The diffusion cloud chamber. A. V. Crewe and W. H. Evans. *Atomics* [*London*] **3**, 221–9 (*Sept.*, 1952).

The theory and operational characteristics of a continuously sensitive diffusion cloud chamber built to operate with the Liverpool 156 in synchro-cyclotron are given, and its advantage over the conventional Wilson cloud chamber discussed. F. LLEWELLYN JONES

537.543

287. Spurious pulses from the type 5819 photomultiplier tube. R. J. Lanter and R. W. Corwin. Letter in *Rev. sci. Instrum.*, **23**, 507–8 (*Sept.*, 1952).

Spurious pulses following scintillation pulses are observed which arise in the photomultiplier and are related to the primary scintillation pulses in amplitude, frequency and duration of occurrence. The origin of the pulses is still obscure. They may arise from positive ion feedback, negative ion motion or metastable electron states in dynode surfaces. G. F. J. GARLICK

537.543 : 621.3.011.22 : 621.385.2

288. On the relation between the conductance and the noise power spectrum of certain electronic streams. J. J. Freeman. *J. appl. Phys.*, **23**, 1223–5 (*Nov.*, 1952).

The noise power spectrum of a diode with a temperature limited current and also for a diode with a retarding field is shown to be the sum of two parts. One, the "pure" shot effect, is the spectrum which would obtain if the electrons were all emitted with zero velocity, that is, if the cathode were at zero temperature (and still maintained the same emitting properties). The second is the thermal contribution, namely, $4kTg$, where T is the cathode temperature and g is the conductance of the electron stream. A.

537.543 : 621.3.014 : 621.385.2

289. Effect of filament voltage on the plate current of a diode. H. F. Ivey. *J. appl. Phys.*, **23**, 1254–6 (*Nov.*, 1952).

The effect of the potential drop across the filament of a diode with directly heated emitter on the anode current of the diode is considered. Calculations are made for both space-charge-limited and retarding-field conditions. Filament heating by direct current and by alternating current is considered. The results are given in convenient graphical form. A.

537.543 : 621.385.2

290. Influence of initial velocities on electron transit time in diodes. J. T. WALLMARK. *J. appl. Phys.*, **23**, 1096–9 (*Oct.*, 1952).

The transit time spread due to difference in initial velocity in a planar diode has been calculated for the case of nonhomogeneous velocity distribution. The spread is given as a function of the current for two practical cases, the normal diode and an inverted diode (a beam reflected in a diode space). The spread is also given as a function of anode voltage within certain limits. The method may be used to estimate the influence of transit time spread on transit time devices. A special application is described. A.

IONIZATION . THERMIONICS 537.56/.58

537.564

291. Alpha-particle ionization in mixtures of the noble gases. W. P. JESSE AND J. SADAUSKIS. Letter in *Phys. Rev.*, **88**, 417 (*Oct.* 15, 1952).

The number of ions per α-particle produced in He containing measured quantities of A, Kr and CO_2 and in Ne containing measured quantities of A, and the average energy for ion pair production are calculated. The effects of impurities are attributed to metastable atoms. F. LLEWELLYN JONES

537.565

292. Drift velocities of ions in krypton and xenon. R. N. VARNEY. *Phys. Rev.*, **88**, 362–4 (*Oct.* 15, 1952).

Drift velocities and mobilities of ions of Kr and Xe in their respective parent gases have been measured over a wide range of values of E/p_0, the ratio of electric field strength to normalized gas pressure. Two ions appear in each gas identified as Kr^+ and Kr_2^+ in Kr and Xe^+ and Xe_2^+ in Xe. The relation that drift velocity varies as $(E/p_0)^{\frac{1}{2}}$ at high E/p_0 has been found to hold for the atomic ions and has been used to determine the equivalent hard sphere cross-sections at high fields. The cross-sections are 157×10^{-16} cm^2 for Kr and 192×10^{-16} cm^2 for Xe. The Langevin theory of mobilities gives excellent agreement with experimental results extrapolated to zero field strength provided that, in the theory, the hard sphere cross-section is taken as large for the atomic ions and very small for the molecular ions. The range of the polarization forces is such as to render them insignificant in atomic ion collisions and of primary importance in molecular ion collisions. A.

537.568

293. Recombination of gaseous ions. H. S. W. MASSEY. *Advances in Phys.*, **1**, 395–426 (*Oct.*, 1952).

Comprehensive review with full bibliography. Electron/positive-ion recombination is discussed theoretically and experimentally. It appears that dissociative recombn. (coeff. $\sim 10^{-7}$ cm^3 sec^{-1} at room temp.) is far more important than radiative recombn. (coeff. $\not> 10^{-11}$ for thermal electrons for O^+) or dielectronic recombn. (coeff. $\not> 10^{-12}$). Three-body recombn. in which an electron is the third body may be important in dense plasmas. Experimental techniques based on measurements of electron concentration as a function of time in discharge afterglows allow distinction between recombn. and ambipolar diffusion as the means of electron removal. Results based on the recent microwave techniques appear reliable but differ from those obtained formerly by optical and electrical probe methods. Interpretation of the value $1\cdot7\times10^{-8}$ for the recombn. coeff. obtained for the He afterglow by microwave techniques in terms of He_2^+ dissociative recombn. is considered in detail. The processes of negative ion-positive ion recombn. are discussed. Applications to the ionosphere (dissociative recombn. probably predominant), and to the theory of the solar corona and chemical composition of interstellar gas (radiative recombn.) are treated. G. M. BROWN

537.583

294. The electronic properties of barium sulfide. W. GRATTIDGE AND H. JOHN. *J. appl. Phys.*, **23**, 1145–51 (*Oct.*, 1952).

BaS has been prepared in a form suitable as a cathode emitter as well as in the form of compressed pills. It has a work function of 2·1 eV with a wide variation possible in activation. The most active materials had an emission at temperatures of 900°K and greater comparable to that from pure BaO. Pure Ni and Pt only were used as base metals. An equimolar mixture of BaS–SrS had a work function of 2·6 eV and X-ray analysis indicated solid solution formation. The electrical conductivity of BaS was found to vary between wide limits depending on the degree of activation and the denseness of the specimen but was much less than for BaO. At 1000°K the specific conductivity of a compressed pill was 10^{-5} ohm^{-1} cm^{-1}. The thermoelectric power was found to be constant with temperature although it decreased with increase in the activity of the specimen. The warmer electrode was always positive. Pure BaS had a thermoelectric power of 2·5 mV per degree between 970° and 1270°K. The effect of added impurities of Fe on the electrical characteristics was studied. By mass-spectrometer studies, the evaporation rate of BaS was found to be much less than that of BaO, indicating a vapour pressure of the sulphide about 100 times less than that of the oxide. The heat of sublimation was found to be 104 kcal/mole. A.

537.5

295. Conductivity of oxide emitters. R. C. HUGHES AND P. P. COPPOLA. *Phys. Rev.*, **88**, 364–8 (*Oct.* 1, 1952).

Measurements of the conductivity of a BaSrCa emitter over a range from room temperature to 1100°K indicate the existence, in well-activated cathodes, of a low temperature conduction mechanism having an activation energy of as little as 0·05 eV. Coincident with the temperature at which appreciable emission can be drawn, a high temperature conduction mechanism of 1 eV activation energy becomes evident. Application of a high pressure (25 atmospheres) of xenon to the cathode causes a marked decrease in conductivity in the high temperature range. These results are considered to confirm a hypothesis recently advanced by Loosjes and Vink that conduction in the high temperature region occurs predominantly through space currents in the pores of the oxide. The small activation energy of the low

perature conduction mechanism is considered to cate the probability that this conduction occurs monolayer of barium on the surface of the oxide. A.

537.583 : 621.385.032.21

Bariated tungsten emitters. R. C. HUGHES D P. P. COPPOLA. *J. appl. Phys.*, **23**, 1261–2 (*Nov.*, 52).

Thermionic emitters consisting of barium oxide persed throughout a body of porous tungsten can successfully made if suitable compounds of barium e employed as the source of the oxide. Compounds ch as the carbonate, which can oxidize tungsten and act to form Ba_3WO_6: $3BaCO_3 + W \rightarrow Ba_3WO_6 + CO$, are unsuitable. However, if by various means, aO is dispersed in tungsten, reaction occurs at erating temperature of the cathode to slowly nerate free barium: $6BaO + W \rightarrow Ba_3WO_6 + 3Ba$, hich diffuses to the surface and lowers the work nction. Cathodes consisting of approximately % of BaO in W are capable of supplying continuous mission in excess of 100 amp/cm², give equivalent .c. and pulsed emission, and are highly resistant to amage by arcing, temporary poor vacuum, ion bombardment and high temperatures. Emission current f approximately 8 amp/cm² was obtained at an perating temperature of 1000°C from a typical athode of this type. The life of this cathode, at 100°C, was in excess of 650 hours. Constants of the Richardson equation for a relatively inactive cathode were $\phi = 1{\cdot}56$ eV, $A = 0{\cdot}6$ amp/cm²/deg². A.

537.583 : 621.385.032.21

297. A survey of present knowledge of thermionic emitters. D. A. WRIGHT. *Instn Elect. Engrs Paper* 404, 15 *pp.* (1953).

An account is given of factors influencing the work ction of metals, values are quoted and the usefulss of a number of metals as practical thermionic mitters is discussed. The effect of adsorbed films is escribed and illustrated in connection with emitters monatomic layers of Th, Cs and Ba. The sion from compounds, and in particular from ni-conductors, is considered and the behaviour of ertain metallic borides and carbides are dealt with. me of these, such as lanthanum boride and thorium oide, are likely to be valuable as practical emitters. e general properties of oxides are discussed, where groups in the periodic table are compared. The , Sr)O type of cathode is treated in some detail. e performance of thoria as a thermionic emitter is cribed. A.

COSMIC RAYS 537.591

537.591 : 778.34

298. A quick method of distortion measurement in nuclear emulsions. J. V. MAJOR. *Brit. J. appl. Phys.*, **3**, 309–10 (*Oct.*, 1952).

A rapid method for measuring the curvature distortion in the tracks of cosmic-ray particles in photographic emulsions is described. The method is applied to the determination of curvature distortion contours on a 400 μ thick G5 nuclear research plate. A.

537.591.1

299. On the nature of *V*-particles. I–II. Y. NAMBU, K. NISHIJIMA AND Y. YAMAGUCHI. Letters in *Progr. theor. Phys.*, **6**, 615–22 (*July–Aug.*, 1951).

Interpretations of a possible case of cascade decay of two *V*-particles reported by Armenteros *et al.* [Abstr. 6297 (1951)] are discussed, and coupling constants given which the authors consider may be in error by a factor of 100. E. P. GEORGE

537.591.1

300. Nucleonic components at high altitudes. K. SAKIHAMA AND S. TAKAGI. Letter in *Progr. theor. Phys.*, **6**, 1017–20 (*Nov.–Dec.*, 1951).

The neutron–proton ratio has been calculated as a function of atmospheric depth taking into account the contribution to the nucleonic component from primary α-particles. The results are compared with available experimental data but no definite conclusions can be drawn because of the scatter of the measured values. H. ELLIOT

537.591.1

301. Production cross section and frequency of neutral mesons in cosmic rays. G. SALVINI AND Y. B. KIM. *Phys. Rev.*, **88**, 40–50 (*Oct.* 1, 1952).

Nuclear interactions have been observed in a large cloud chamber operated at Echo Lake, Colorado, altitude 10 500 ft. The events were produced by ionizing particles (protons) in NaI crystals inside the cloud chamber, and were detected by photomultipliers. In this paper the electromagnetic component associated with the nuclear events is studied as evidence for the properties of the neutral meson whose decay is assumed to be the source of this component. The results are consistent with the assumption that the π^0 mesons are the main source of the photons associated with the nuclear events. The probability of production of π^0 mesons is in agreement with the theoretical results of Fermi, within the limits of the large experimental errors. The ratio of the number of neutral π^0 mesons to the number of the charged $\pi^{\pm}$ mesons is estimated in events of different multiplicities of shower particles and it is found to be close to $0{\cdot}5$ for events with multiplicity varying from 1 to 5 or more (corresponding to energies of from 1 to about 20 BeV for the producing protons). These results agree with the results of other experimenters, if all the possible systematic errors are taken into account. The estimated energy distribution of the π^0 mesons emitted is given. A.

537.591.1

302. Intensity of the soft and hard component of the cosmic radiation as a function of altitude at geomagnetic latitudes of 28° N, 41° N, and 55° N. M. L. VIDALE. *Phys. Rev.*, **88**, 266–72 (*Oct.* 15, 1952).

Counter telescopes have been flown with plastic balloons to a maximum altitude of 94 000 ft. Intensity *v.* pressure curves have been obtained at geomagnetic latitudes of $\lambda = 55°$, 41° and 28° for the total cosmic radiation and for the components capable of traversing several thicknesses of lead. The energy spectrum of primary cosmic-ray particles has been derived from the extrapolation of the intensity of the total radiation to the top of the atmosphere. The integral momentum spectrum of the total primary

U. OF I.
LIBRARY

radiation is given by $N(>pc/Ze) = 0{\cdot}49(pc/Ze)^{-1{\cdot}0}$ The results show that the radiation originating from primaries in the energy range 1 to 4 BeV (cut-off energies at $\lambda = 55°$ and 41°) is predominantly of a nucleonic nature. The absence of an appreciable electronic component can be explained by assuming that, close to the top of the atmosphere, electrons originate predominantly from the decay of neutral mesons and that, within this energy range, the over-all probability of nucleon emission is greater than that of meson production. In sharp contrast, the soft component originating from primaries in the range from 4 to 8 BeV (cut-off at $\lambda = 41°$ and 28°) multiplies rapidly in the atmosphere. This large transition effect in air with a maximum at about 10 cm Hg pressure is very characteristic of electron showers. It is concluded that the probability of neutral mesons being produced is comparatively high at primary energies between 4 and 8 BeV. At energies higher than 8 BeV this effect is even more pronounced, due to the contribution of the plural and multiple production of mesons. A.

537.591.1

303. Rocket determination of the ionization spectrum of charged cosmic rays at $\lambda = 41°$ N. G. J. Perlow, L. R. Davis, C. W. Kissinger and J. D. Shipman, Jr. *Phys. Rev.*, **88**, 321–5 (*Oct.* 15, 1952).

In a V-2 rocket measurement at $\lambda = 41°$ N an analysis has been made of the various components of the charged particle radiation on the basis of ionization and absorption in lead. The ionization was determined by two proportional counters, the particle paths through which were defined by Geiger counters. With increasing zenith angle toward the north, the intensity is found to be substantially constant until the earth ceases to cover the under side of the telescope. The intensity of all particles with range $\leqslant 7$ g/cm² is $0{\cdot}079 \pm 0{\cdot}005$ (cm² sec steradian)$^{-1}$. Of this an intensity $0{\cdot}012 \pm 0{\cdot}002$ is absorbed in the next 14 g/cm². The ionization measurement is consistent with $\frac{3}{4}$ of these soft particles being electrons of $< \sim 60$ MeV, the remainder being slow protons and α-particles. For the particles with greater range an ionization histogram is plotted, the smaller of the two ionization measurements for a single event being used to improve the resolution. The particles divide into protons, α-particles and one carbon nucleus, with $N_p/N_\alpha = 5{\cdot}3 \pm 1{\cdot}0$. Their absorption is exponential with mean free path 440 ± 70 g/cm² Pb. Extrapolating to zero thickness, the total primary intensity is $0{\cdot}070 \pm 0{\cdot}005$ (cm² sec steradian)$^{-1}$ with $0{\cdot}058 \pm 0{\cdot}005$ as protons, $0{\cdot}011 \pm 0{\cdot}002$ as α-particles and $0{\cdot}001 \pm 0{\cdot}001$ as $Z > 2$. A.

537.591.1

304. The spread of the soft component of the cosmic radiation. H. S. Green and H. Messel. *Phys. Rev.*, **88**, 331–8 (*Oct.* 15, 1952).

The fundamental diffusion equations describing the three-dimensional development of the electron-photon component of the cosmic radiation, are formulated. These equations take into account exactly ionization loss and variation of density in the medium, and enable one to determine all angular and radial moments of the distribution functions, as explicit functions of depth and energy for arbitrary initial conditions. The exact general solution of these equations obtained in this paper are readily adapted to any physical situation of interest. The method is similar to that devised by the authors in considering the three-dimensional development of the nucleon component. The only approximations involved are those inherent in the Bethe–Heitler cross-sections in the full screening approximation, and the neglect of angular deflections in processes other than elastic Coulomb scattering. It is shown that all previous work is subject to very large errors on the following counts: (1) the neglect of fourth and higher angular moments for the Coulomb scattering in Landau's equation and equivalent integral equations; (2) the neglect of variation of density in the atmosphere—which alone can lead to errors as high as 5000%; (3) elimination of the depth dependence either by integration over all depths, or evaluation in the neighbourhood of the cascade maximum; (4) miscellaneous errors introduced in the evaluation of already approximate integrals; (5) use of results due to Moliere, hitherto unpublished in detail, which involve errors of several orders of magnitude in the higher moments; and also in the distribution functions concerned. No calculation of the actual distribution functions in the atmosphere or elsewhere has yet been made on the basis of a realistic physical model. The results obtained in this paper will allow the authors to do this in the future. A.

537.591.15

305. Note on the cascade function for heavy elements. J. Nishimura and K. Ida. Letter in *Progr. theor. Phys.*, **6**, 905–7 (*Sept.–Oct.*, 1951).

Results of a calculation of the number of shower particles as function of depth when deviations from the shower axis are not neglected. W. J. Swiatecki

537.591.15

306. Note on the statistical theory of the meson shower. S. Takagi. Letter in *Progr. theor. Phys.*, **7**, 123–5 (*Jan.*, 1952).

A modification of Fermi's meson-production theory, in which the energy of nucleon-nucleon collision is localized in two regions, each radiating mesons according to the theory of statistical equilibrium.

R. H. Dalitz

537.591.15

307. Note on the fluctuation problem in cascade theory. H. Messel and R. B. Potts. *Proc. Phys. Soc.* [*London*] *A*, **65**, 854–6 (*Oct.*, 1952).

A general relation between two fundamental functions appearing in fluctuation problems in cascade theory is derived. This leads to a direct method of solving for the nth moments of the distribution function. It is also shown that the Jánossy G-equations are superfluous for the solution of the fluctuation problem. See also Abstr. 6610 (1952). A.

537.591.15

308. The absorption mean free path of large hard showers in air. H. K. Ticho. *Phys. Rev.*, **88**, 236–41 (*Oct.* 15, 1952).

In this report an experiment is described in which altitude curves of hard showers of various sizes produced in a lead block were obtained. The sizes were determined by means of a hodoscope; for the largest

hard shower group a minimum energy of 260 BeV was estimated by extrapolation to the top of the atmosphere. All altitude curves show an exponential absorption in the atmosphere with a mean free path of $\sim$125 g/cm^{-2}. It appears that these large attenuation lengths are difficult to reconcile with a geometric collision mean free path for a nucleon-nucleus collision. A.

537.591.3

309. Ionization chamber measurements of the absorption of the *N*-component of cosmic rays in lead. H. S. Bridge and R. H. Rediker. *Phys. Rev.*, **88**, 206–24 (*Oct.* 15, 1952).

A detecting system that responds only to ionization bursts produced by nuclear interactions of the so-called *N*-component of cosmic radiation is described. The burst rate observed with this detector has been measured as a function of the thickness of lead absorber above the system at sea level and at 10 600 ft. The absorption of the *N*-component in lead cannot be represented by an exponential variation of the intensity with absorber thickness instead the "absorption curve" shows an initial increase in intensity. This behaviour may be explained by the assumption that π-mesons with energies of several BeV, which are produced in the nuclear interactions, can give rise to further nuclear interactions. From the altitude variation of the smallest recorded bursts produced by the *N*-component, one finds a value of 119 $\pm$ 5 g/cm^{-2} for the absorption thickness of the producing radiation in air. The absorption thickness decreases with increasing energy of the nuclear event detected. In the same experiment, other kinds of events were also recorded, which could be produced either by *N*-rays or by μ-mesons. The bursts produced by these two components were separated on the basis of the experimental altitude variation of *N*-rays and of the computed altitude variation of the μ-meson induced bursts. For the ionization chamber used about 50% of the bursts at sea level produced by charged particles incident on the 219 g/cm^{-2} lead ionization chamber shield were caused by μ-mesons and 50% by the *N*-component. A.

537.591.8

310. The close pair effect in cosmic-ray stars. K. E. Davis, J. B. Marion, J. F. Delord and K. M. King. *Phys. Rev.*, **88**, 368–72 (*Oct.* 15, 1952).

Evidence is presented to establish the existence of the close pair effect in cosmic-ray stars formed in nuclear emulsions exposed at 95 000 ft. A reasonable estimate of the magnitude of the effect may be derived from the data obtained, and this magnitude is compared with that obtained from similar studies at lower altitudes. It appears that a maximum for the excess of close pairs occurs for separations $\leq$1 mm in the emulsions exposed at balloon altitudes. It is extremely difficult to explain the effect on the basis of present knowledge. A.

537.591.8

311. Emulsion cloud-chamber observations on the interactions of high energy primary cosmic radiation. M. F. Kaplon and D. M. Ritson. *Phys. Rev.*, **88**, 386–97 (*Oct.* 15, 1952).

The initial investigations with the emulsion cloud chamber are surveyed. A study of some "purely electronic" showers is presented and an upper limit on the electron-photon component of the primary radiation is given as $\leq$2% of the proton component at energies in excess of $\sim 3\times10^{11}$ eV. High energy nuclear interactions occurring in brass are discussed, and evidence is presented for the similarity of nucleon-nucleon and nucleon-nucleus interactions at very high energies. A study of the soft radiation produced in these interactions gives a ratio of neutral mesons to charged particles of 0·5. The primary proton spectrum is extended to energies of approximately 5×10^{12} eV, and evidence is presented for the constancy of the α-particle to proton ratio in the primary flux up to these energies. A.

MAGNETISM 538

538.082.74 : 621.317.41

312. A method of measuring the magnetic permeability of rod specimens. H. Aspden. *J. sci. Instrum.*, **29**, 371–2 (*Nov.*, 1952).

The method consists in detecting changes in flux density and field strength by search coil and fluxmeter means. A feature is introduced whereby a repeated reversal of magnetizing field results in the field-indicating fluxmeter adding all the field changes in the same sense so that the customary compromise between accuracy and sensitivity involved in direct measurements of field strength is avoided. The method is extended by connecting in opposition the field search coil and the flux search coil so that the above arrangement can be used as a sensitive flux-balance indicator and the accuracy of a permeability measurement rendered substantially independent of fluxmeter errors. A.

538.082.74 : 621.317.444

313. A rotating coil fluxmeter. M. S. Wills. *J. sci. Instrum.*, **29**, 374–5 (*Nov.*, 1952).

The instrument consists of a search coil mounted on a hollow flexible shaft and rotated at a constant speed of about 3000 r.p.m. in the unknown magnetic field. The alternating e.m.f. is picked up by means of a transformer the primary of which is attached to, and revolves with, the search coil while the secondary is stationary. The secondary e.m.f. is amplified and measured by an electronic voltmeter giving a reading proportional to the flux linkage. The maximum sensitivity of the present instrument is $1\cdot63\times10^5$ maxwell-turns for full scale deflection, but could be increased. The amplifier is compensated for speed variations arising from changes in frequency of the a.c. mains. The instrument is absolute and the method of calibration using a sub-standard dynamometer is described. A.

538.113

314. Exchange coupling and the Curie–Weiss law. R. K. Wangsness. Letter in *J. chem. Phys.*, **20**, 1656 (*Oct.*, 1952).

Shows that the high-temperature susceptibility of a pair of exchange-coupled spins can be expressed approximately in the form of a Curie–Weiss law.

E. P. WOHLFARTH

538.114

315. Statistics of two-dimensional Ising lattices of chequered types. T. Utiyama. Letter in *Progr. theor. Phys.*, **6**, 907–9 (*Sept.–Oct.*, 1951).

Gives a statistical treatment for a general array from which many other two-dimensional arrays may be derived as special cases. The partition function is evaluated and Curie temperatures are deduced.

E. P. WOHLFARTH

538.12

316. Ring shims for coned magnet polecaps. E. R. Andrew and F. A. Rushworth. *Proc. Phys. Soc.* [*London*] *B*, **65**, 801–5 (*Oct.*, 1952).

The calculation of ring shims of the kind suggested by Rose (1938) has been extended to include polecaps in the form of truncated cones. Design data are presented in graphical form. Actual and predicted performances are compared for one magnet. A.

538.221/.222

317. A commentary to Yosida's theory on FeS_n. S. Miyahara. Letter in *Progr. theor. Phys.*, **6**, 1026–7 (*Nov.–Dec.*, 1951).

See Abstr. 1114 (1952). Yosida's discussion is amended by including an electrostatic term in the total energy expression. With an assumed value of the Madelung constant it is shown that for $n < 1{\cdot}1$ paramagnetism must always occur, in agreement with experiment. E. P. WOHLFARTH

538.221

318. Ferromagnetism of some gadolinium–magnesium alloys. F. Gaume-Mahn. *C.R. Acad. Sci.* [*Paris*] **235**, 352–4 (*Aug.* 4, 1952) *In French.*

See Abstr. 7095 (1951). Reports measurements between 78° and 300°K on alloys with composition close to GdMg. The Curie temperature for all alloys is equal to 102 ± 3°K. Above about 150°K the Curie–Weiss law is obeyed, giving $p_B = 6{\cdot}87$, $7{\cdot}49$ for Gd concentrations 78%, 84% by weight respectively, cf. $p_B = 7{\cdot}95$ for pure Gd. E. P. WOHLFARTH

538.221

319. Antiferromagnetism of atoms on different crystallographic lattice sites. C. Guillaud. *C.R. Acad. Sci.* [*Paris*] **235**, 468–70 (*Aug.* 18, 1952) *In French.*

It is suggested, on the basis of magnetic measurements by the author, that in the ferromagnetic compounds Mn_2Sb, Mn_4N, Mn_2As, MnP, CrTe the interaction between atoms in different spectroscopic states and on different lattice sites is negative.

E. P. WOHLFARTH

538.221 : 621.318.12 : 621.318.2

320. A new permanent magnet from powdered manganese bismuthide. E. Adams, W. M. Hubbard and A. M. Syeles. *J. appl. Phys.*, **23**, 1207–11 (*Nov.*, 1952).

Permanent magnets in present use consist chiefly of alloys containing cobalt or nickel, or both. Because these elements are currently scarce, possible substitute materials were examined. The intermetallic compound manganese bismuthide was chosen for this investigation because it has the highest recorded magnetic crystal anisotropy. The new permanent magnet was prepared by hot pressing finely pulverized MnBi in the presence of a strong magnetic field to facilitate particle alignment. Some of these compacts showed a maximum energy product $(BH)_{max}$ as high as $4{\cdot}3 \times 10^6$ gauss-oersteds, a coercive force (H_c) of 3400 oersteds and a residual flux density (B_r) of 4300 gauss. This preliminary work shows that aside from its possibilities as a substitute for magnets requiring cobalt, this new magnet material has a value which exceeds present materials for special applications where a high coercive force is desirable, e.g. where one cannot use a magnet that is long compared to the air gap required. There is also theoretical possibility of further improvement in maximum energy product. A.

538.222

321. The characteristic thermomagnetic curve for vanadium tetroxide between 81° and 680°K. N. Perakis and J. Wucher. *C.R. Acad. Sci.* [*Paris*] **235**, 354–6 (*Aug.* 4, 1952) *In French.*

The $1/\chi$, T curve for a V_2O_4 specimen containing 3% V_2O_3 is anomalous below about 350°K. At this temperature χ increases suddenly by a factor of about 3 on heating. Above this temperature the Curie–Weiss law is obeyed with $p_B = 2{\cdot}1$. On cooling again below this temperature strong temperature hysteresis was observed. In all cases χ is field independent. E. P. WOHLFARTH

538.222

322. Magnetic properties of the palladium–rhenium system. J. Wucher and N. Perakis. *C.R. Acad. Sci.* [*Paris*] **235**, 419–21 (*Aug.* 11, 1952) *In French.*

Describes measurements between 93° and 733°K on 8 alloys and the pure metals. Alloys with <17% Re are single phase, their room temp. susceptibility decreases very rapidly with increasing Re concentration and the (negative) Curie temperature increases linearly. The "valency" of Re is deduced to be >7. For the two-phase alloys (>17% Re) the susceptibility is independent of composition, being equal to about 60×10^{-6} per gram atom. E. P. WOHLFARTH

538.222

323. Paramagnetic resonance absorption in additively colored crystals of alkali halides. C. A. Hutchison, Jr and G. A. Noble. Letter in *Phys. Rev.*, **87**, 1125 (*Sept.* 15, 1952).

Describes measurements at room temperature and at 9000 Mc/s on KCl and KBr crystals containing excess K. The absorption curve characteristics show that the excess K, present as *F*-centres, may be dispersed in colloidal form in the salts. The *g*-factor was found to equal 1·995. E. P. WOHLFARTH

538.222

324. The anomalous paramagnetism of copper sulfate pentahydrate. W. E. Henry. Letter in *Phys. Rev.*, **87**, 1133 (*Sept.* 15, 1952).

A plot of the relative magnetization against H/T at four low temperatures shows systematic deviations from a unique Brillouin function. The anomaly is tentatively interpreted. E. P. WOHLFARTH

538.222

325. Paramagnetic resonance in liquids. M. A. Garstens and S. H. Liebson. Letter in *J. chem. Phys.*, **20**, 1647–8 (*Oct.*, 1952).

Water solutions of $Mn(NO_3)_2$ were studied. At low concentration 6 h.f. lines were observed, which

disappeared at higher concentrations while the total line width decreased. These effects are due mainly to exchange between the electrons and also to changes of the re-orientation time in the Brownian motion of the liquid. L. PINCHERLE

538.224 : 539.13

326. The diamagnetic anisotropy of large aromatic systems. IV. The polyacenes. R. McWEENY. *Proc. Phys. Soc.* [*London*] *A*, **65**, 839–44 (*Oct.*, 1952).

For Pt III, see Abstr. 406 (1952). The π-electron diamagnetic susceptibilities of polyacenes of up to ten rings are calculated by a method introduced in previous Pts: the method, which involves only a single numerical integration, is simplified. An alternative method of calculation, which has certain attractions and is widely applicable, is sketched in an appendix. The relationship between the diamagnetic anisotropy and the number of rings in the molecule is found to be almost linear. A.

538.24

327. The de Haas–van Alphen effect in enriched tin isotopes. T. G. BERLINCOURT. *Phys. Rev.*, **88**, 242–8 (*Oct.* 15, 1952).

The de Haas–van Alphen effect has been investigated in Sn isotopes in the liquid He temperature range, and no conclusive evidence has been found indicating a dependence of the effect upon atomic mass. However, some new features of the effect have been investigated which are interpreted as being caused by at least two independent groups of electrons. One group of electrons, having effective masses $m_3 = 1{\cdot}1\, m_0$ (where m_0 is the free electron mass) parallel to the tetragonal axis and $m_1 = 0{\cdot}16\, m_0$ perpendicular to the tetragonal axis, and having a chemical potential of $E_0 = 0{\cdot}25$ eV, gives rise to short period oscillations in the magnetic susceptibility as the magnetic field is varied. A second group of electrons having a chemical potential $E_0 = 0{\cdot}20$ eV and for which the effective masses are not so clearly defined give rise to longer period oscillations such that the observed de Haas–van Alphen oscillations exhibit beats between the long and short period terms. A.

538.24

328. Spontaneous magnetization of a triangular Ising lattice. R. B. POTTS. *Phys. Rev.*, **88**, 352 (*Oct.* 15, 1952).

The spontaneous magnetizations for the anisotropic rectangular and triangular Ising lattices are obtained by generalizing Yang's result for the isotropic square Ising lattice. A.

538.242

329. A new gyromagnetic effect in Permalloy and iron. S. J. BARNETT AND L. A. GIAMBOMI. *Phys. Rev.*, **88**, 28–37 (*Oct.* 1, 1952).

A long circular cylinder of compressed ferromagnetic powder is magnetized along its axis to an intensity of magnetization J_z, near saturation, so that the moments of all of the magnetic elements point essentially in the same direction Z. In a direction X, normal to Z, a small magnetic intensity H_x with frequency f, such that $1/f$ is much greater than the relaxation time, is applied. This causes the intensity of magnetization to oscillate synchronously through a small angle in the XZ-plane; and this leads to the development of an intensity of magnetization J_y in the transverse direction Y and proportional to H_x. From measurements of J_y, or the corresponding magnetic induction B_y, the longitudinal magnetization J_z, the frequency f, and the transverse permeability $\mu_x = \mu_y$, the gyromagnetic ratio ρ can be calculated for approximate saturation. For both Permalloy and iron rods, steadily magnetized longitudinally in very intense fields and cross magnetized at frequencies of 22 and 30 kc/s in very weak fields, the values obtained for ρ do not differ by more than the experimental error from those obtained for the same substances (though in a different physical state) in experiments on the Barnett and Einstein–de Haas effects. A.

ELECTROMAGNETISM . ELECTRODYNAMICS 538.3/.5

538.3 : 530.12

A simplified form of the relativistic electromagnetic equations. *See Abstr.* 22

ELECTROMAGNETIC WAVES AND OSCILLATORS 538.56

538.561 : 535.343–14

Summarized proceedings of a conference on microwave physics—Oxford, July 1952. *See Abstr.* 124

538.561 : 537.525.8

On the plasma-like oscillation. *See Abstr.* 255

538.566

330. On the non-existence of Sommerfeld's surface wave. P. POINCELOT. *C.R. Acad. Sci.* [*Paris*] **235**, 350–2 (*Aug.* 4, 1952) *In French.*

A mathematical oversight in Sommerfeld's original paper is pointed out. L. PINCHERLE

538.566 : 535.42

331. The unicity of the solution in the exact theory of diffraction. H. HÖNL AND A.-W. MAUE. *Z. Phys.*, **132**, *No.* 5, 569–78 (1952) *In German.*

It is shown, in the case of plane diffraction problems, that the existence of fields radiated by the edge of the screen which would not fulfil Meixner's condition [see Abstr. 5976 (1950)] is automatically excluded by the integral equations for the Fourier components of the wave field. L. PINCHERLE

538.566

332. The waves in a pyramidal horn. E. G. ZELKIN. *Zh. tekh Fiz.*, **21**, *No.* 10, 1228–39 (1951) *In Russian.*

The author states that while pyramidal e.m. horns are very widely used, the theory of the waves inside such a horn had not yet been considered in the literature. This can be attributed to the fact that in a pyramidal horn the walls do not coincide with the coordinate surfaces of any standard coordinate system. In order to overcome this difficulty E. N. Mayzels suggested a very slight modification which would make this type of e.m. horn readily analysable with the aid of spherical coordinates, namely, by making two opposite walls as a part of a bicone with an apex

coinciding with the apex of the pyramid, instead of plane. Mayzels himself investigated only one type of the waves in such horn, which in a now generally accepted notation can be marked as H_{01} waves, and even this was restricted to the case of a small angle of opening. The object of the paper is to give a more complete investigation of such waves. He begins with the Maxwell equations in spherical coordinates, $r\phi\theta$, and by substituting, in the case of H-waves, $r \sin \theta\, E_\theta = \partial u/\partial\phi$ and $-rE_\phi \equiv \partial u/\partial\theta$, he obtains a differential equation with respect to u, which can be solved in the terms of Legendre functions of the first and second type, $P_\rho^{l\nu}(\cos\theta)$ and $Q_\rho^\nu(\cos\theta)$, and Bessel functions of the first and second kind, $J_{\rho+\frac{1}{2}}(kr)$, and $N_{\rho+\frac{1}{2}}(kr)$, resp., where k is the wave number multiplied by 2π. In the case of E-waves the procedure is the same, but E and H are interchanged. The introduction of the Sommerfeld radiation condition allows of substitution of the Hankel functions of the second kind, $H^{(2)}_{\rho+\frac{1}{2}}$ for the Bessel functions. He then finds the nodal surfaces by finding the roots of corresponding equations, by using a method of approximation, and gives field diagrams of different types of such waves, obtained from these calculations. N. S. JAPOLSKY

538.566 : 538.612

Magnetic double refraction at microwave frequencies. *See Abstr.* 339

538.566 : 621.3.011.21 : 621.392.26 : 621.317.332.1

333. The concept and measurement of impedance in periodically loaded wave guides. E. T. JAYNES. *J. appl. Phys.*, **23**, 1077–84 (*Oct.*, 1952).

A generalization of ordinary circuit theory which enables one to define impedances in any periodic structure is developed, based on the concept of expansion of electromagnetic fields in terms of a set of linearly independent basis fields. Techniques for measurement of impedances in a periodic structure are described, involving a determination of the parameters of a coupling system by an extension of the well-known nodal shift method. A.

538.566 : 621.396.671

334. Theory of electrically short transmitting and receiving antennas. R. KING. *J. appl. Phys.*, **23**, 1174–87 (*Oct.*, 1952).

Complete and quantitatively accurate solutions of the properties of electrically short transmitting and receiving aerials (of length $2h$ such that $2\pi h/\lambda_0 \leqslant 1$) are obtained by determining the distributions of current that actually satisfy the integral equations. Components of current in phase and in phase-quadrature with the driving voltage or the incident electric field are evaluated together with the impedance, the effective length, and the gain. It is shown that when the King–Middleton method of solving Hallén's integral equation by iteration is applied correctly, quite accurate results are obtained even in a first-order solution. The greatest error in the first-order formulas is shown to be in the resistance, a small quantity of higher order compared with the reactance. The newly determined values are combined with the King–Middleton second-order results to obtain more complete and more accurate impedances and effective lengths in the range of $0 \leqslant 2\pi h/\lambda \leqslant 1{\cdot}4$. A.

538.566.2

335. Scattering of electromagnetic energy in a randomly inhomogeneous atmosphere. H. STARAS. *J. appl. Phys.*, **23**, 1152–6 (*Oct.*, 1952).

First-order perturbation theory is used to evaluate the scattered power at a receiver resulting from random inhomogeneities in the propagating medium. The integral expression for this scattered power is equivalent to the expressions as used by Pekeris and Booker and Gordon. However, it is shown that it is not appropriate to use a space correlation function of refractive index as defined by the above authors. Instead, this paper defines a time correlation function of refractive index which permits formal evaluation of the time average scattered power. It is also shown that, whereas a space correlation function of refractive index is not amenable to direct experimental evaluation, the time correlation function as defined here is directly measurable. Finally, it is shown that for so-called small-scale turbulence the average scattered power does not depend appreciably on any particular model of atmospheric turbulence, whereas for large-scale turbulence the frequency and scattering angle dependence of the scattered energy is affected greatly by the particular time correlation function chosen or by the assumption that scattering is the result of randomly located spheres. A.

538.566.2 : 621.396.11

336. New determinations of the velocity of radio waves. C. I. ASLAKSON. *Trans Amer. Geophys. Un.*, **32**, 813–21 (*Dec.*, 1951).

The author deduces a new value (299 794·2 ± 1·4 km/sec) for the velocity of propagation of radio waves in a vacuum, as compared with the value of 299 792·4 ± 2·4 km/sec which he had previously reported. Whereas both values were determined by comparison of Shoran and geodetic measurements of distances between widely separated points, the new value results from comparisons with improved Shoran equipment. The improvements are discussed, with emphasis on the introduction of a gain-riding technique to reduce signal intensities to a constant level and eliminate the possible uncertainties in the signal-intensity corrections which were applied in the earlier determination. The methods of making Shoran measurements are outlined and the results of a least-square adjustment of the new Shoran data are discussed. In view of the corroborative evidence from other recent determinations, the author recommends abandonment of the Birge statistical value of the velocity of light and states that a value of 299 793 km/sec has been adopted for current Shoran measurements. A.

538.566.3

337. On the mean velocity of propagation of the energy in an heterogeneous absorbing ionized medium with slowly varying parameters. H. ARZELIÈS. *C.R. Acad. Sci.* [*Paris*] **235**, 421–3 (*Aug.* 11, 1952) *In French.*

If this velocity is v, and u indicates the phase velocity, it is proved that $c^2/uv = 1 + k^2$, the definition of k being that the amplitude in the direction z perpendicular to the surface of equal parameters decreases according to a factor $\exp(-2\pi kz/\lambda_0)$, where λ_0 = wavelength *in vacuo*. L. PINCHERLE

538.566.3 : 523.755

338. On the influence of the electron-electron impacts upon the absorption of radio-waves in the *F*-layer of the ionosphere and in the corona of the sun. V. L. GINZBURG. *Zh. tekh. Fiz.*, **21**, *No.* 8, 943–7 (1951) *In Russian.*

Using the previous results obtained by himself and other authors, the author derives a formula for the calculation of the frequency of the impacts between electrons and molecules. The use of this formula, however, requires the knowledge of the temperature of the ionized layer, or other corresponding data, which must be obtained independently of the measurement of the absorption of the radiowaves. In principle, as the author shows, the measurements of this absorption might be sufficient to determine the frequency of electron-electron impacts, but this could hardly be applied in actual practice, because the electron-electron impacts would have but very little influence upon the absorption in comparison with the electron-molecule impacts, unless the wavelength is very much larger than 200 m, and this does not seem to be of practical interest. The author suggests, however, that means for the measurements necessary for the calculation of the frequency of electron-molecule impacts in the ionized layers could be devised. N. S. JAPOLSKY

MAGNETIC EFFECTS 538.6

538.612 : 538.566

339. Magnetic double refraction at microwave frequencies. M. T. WEISS AND A. G. FOX. Letter in *Phys. Rev.*, **88**, 146 (*Oct.* 1, 1952).

This was demonstrated by the conversion from linear to elliptical polarization of a dominant *TE* wave in a section of circular waveguide filled with ferrite and subjected to a steady magnetic field transverse to the direction of propagation and at 45° to the input polarization. A simple theory is also given, in agreement with experimental results. L. PINCHERLE

538.632

340. Sensitive recording alternating-current Hall effect apparatus. E. M. PELL AND R. L. SPROULL. *Rev. sci. Instrum.*, 548–52 (*Oct.*, 1952).

An apparatus is described which will measure mobilities of the order of 10^{-2} cm²/volt-sec in semiconductors. It is especially suited for measuring Hall voltage in samples of very low conductivity—as low as 10^{-11} ohm^{-1}-cm^{-1}. This sensitivity is achieved by use of a magnetic field which is automatically reversed every 6 sec, an oscillator of frequency 24 c/s and an a.c. amplifier and phase-sensitive detector with a recorder output. Such an arrangement lends itself to quick independent testing of the component units and easier interpretation of unusual experimental results. A novel feature is the use of an amplidyne control circuit for regulation of the magnet current and reduction of the time required to reverse the magnetic field. A.

538.652

341. Magnetostriction of cobalt ferrites as a function of composition. R. VAUTIER. *C.R. Acad. Sci.* [*Paris*] **235**, 356–8 (*Aug.* 4, 1952) *In French.*

Gives curves showing the field variation (up to 12 000 oersted) at room temp. for ferrites having CoO contents between 35 and 48%, marked differences, including differences in sign, being found in orientated and non-orientated specimens (see also abstract following). E. P. WOHLFARTH

538.652

342. Thermal variation of the magnetostriction of cobalt ferrite. R. VAUTIER. *C.R. Acad. Sci.* [*Paris*] **235**, 417–19 (*Aug.* 11, 1952) *In French.*

Describes measurements at 77°, 193° and 293°K up to fields of 11 000 oersted for an orientated and a non-oriented specimen with compositions $48CoO.52Fe_2O_3$ and $44CoO.56Fe_2O_3$ respectively. The peculiar low temperature results for the orientated specimen are interpreted by invoking a change of the magnetization vector from one to another easy axis of magnetization (see also preceding abstract).

E. P. WOHLFARTH

MOLECULAR AND ATOMIC STRUCTURE 539.1

THEORY OF SOLID STATE 539.11

539.11

343. On the constitution of copper-gold alloy. T. EGUCHI. *Mem. Fac. Sci. Kyūsyū Univ. B*, **1**, *No.* 1, 25–31 (1951).

A quantum-mechanical calculation of the cohesive energy of Cu_3Au, using Wigner and Seitz's method and employing an approximate average expression for the lattice field. The total energy $E = a + bS^2$ where S is the long range order and a and b are constants independent of S. Thus the ordering energy varies with S in the same manner as in the Bragg–Williams theory: but the calculated energy difference between the fully ordered and fully disordered states is about 4 times greater than that found experimentally. The type of average lattice field employed in the calculations precludes comparison of the results with the Bethe or the Peierls theory. A. D. LE CLAIRE

539.11

344. Studies in graphite and related compounds. I. Electronic band structure in graphite. C. A. COULSON AND R. TAYLOR. *Proc. Phys. Soc.* [*London*] *A*, **65**, 815–25 (*Oct.*, 1952).

The Bloch (tight-binding) approximation is applied to a study of graphite. The mean energy per atom and the internuclear distance are calculated in good agreement with experiment. Previous accounts are extended by including certain overlap integrals and by dealing with a set of parallel layer planes instead of only one plane. The shape of the band due to the π-electrons is calculated, and the experimental X-ray emission spectrum of graphite is interpreted. It is concluded that the role of σ-electrons is greater than is often supposed. A.

539.11

345. Studies in graphite and related compounds. II. Momentum distribution in graphite. W. E. DUNCANSON AND C. A. COULSON. *Proc. Phys. Soc.* [*London*] *A*, **65**, 825–33 (*Oct.*, 1952).

The space wave functions for the π-electrons in a graphite layer, as found in Pt I, are transformed into momentum coordinates, and the radial distribution function, including σ-electrons and π-electrons, is calculated. Using the theory of Jauncey and DuMond the shape of the Compton profile in X-ray scattering is predicted. Both this, and the momentum distribution, are in excellent agreement with experimentally determined values. The introduction of a plausible scale factor in the atomic wave functions would make the agreement almost perfect. A.

539.11

346. Studies in graphite and related compounds. III. Electronic band structure in boron nitride. R. TAYLOR AND C. A. COULSON. *Proc. Phys. Soc.* [*London*] *A*, **65**, 834–8 (*Oct.*, 1952).

An analysis is made of the distribution of π-electrons in the crystal of BN. The insulating character of this substance is shown by the fact that these electrons completely occupy one band, of width approximately 2·4 eV, separated from the next higher band by a gap of about 4·6 eV. The density of states in the band is calculated, accurately for a single layer plane, and approximately for the three-dimensional crystal. Until the energies of the σ-electrons are better known, further progress in understanding this substance will be difficult. A.

539.11 : 530.145

Quantum theory of matter. *See Abstr.* 26

539.11 : 535.343.9

The van der Waals contribution to the cohesive energy of the noble metals. *See Abstr.* 139

MOLECULAR STRUCTURE 539.13

539.13

347. Inter- and intramolecular energy transfer processes. II. Hydrocarbon-hydrocarbon systems. M. M. MOODIE AND C. REID. *J. chem. Phys.*, **20**, 1510–15 (*Oct.*, 1952).

For Pt I, see Abstr. 7449 (1952). The transfer of energy from one species of hydrocarbon to another has been observed. The conditions under which such transfer occurs indicate that one aromatic hydrocarbon may be adsorbed on to crystals of the other forming a surface complex with a binding energy of a few hundred calories. Transfer of energy occurs readily between the components of this complex but not between molecules of different hydrocarbons when both are in solution. However, evidence for resonance transfer of energy between pairs of molecules of the same substance when both are in solid solution has been found. A.

539.13

348. Calculation of vibrational relaxation times in gases. R. N. SCHWARTZ, Z. I. SLAWSKY AND K. F. HERZFELD. *J. chem. Phys.*, **20**, 1591–9 (*Oct.*, 1952).

Vibrational relaxation times in gases are calculated with the method of Zener using an exponential repulsion in a one-dimensional model. The constants of the interaction potential are determined by fitting it to the data of Hirschfelder *et al.* [Abstr. 1564 (1950)]. The great effect which some impurities have is accounted for either by their low mass and resultant high velocity or by "near resonance" transfers in which the vibrational quantum of the substratum is used partly to excite the vibration of the impurity, only the difference being transferred to translation. However, there are other impurities, the action of which cannot be explained in this manner. The theoretical values for the relaxation times are 10 to 30 times shorter than the experimental ones, which difference may be accounted for by the use of the one-dimensional model. Macroscopic equations governing the more complex relaxation processes in polyatomic gases and gas mixtures are developed. A.

539.13

349. Intermolecular potentials for the systems CO_2—CO_2 and CO_2—N_2O. I. AMDUR, J. ROSS AND E. A. MASON. *J. chem. Phys.*, **20**, 1620–3 (*Oct.*, 1952).

Experimental values of self diffusion and mutual diffusion coefficients, in the range −78° to 90°C, have been used to determine the intermolecular potentials for the systems CO_2—CO_2 and CO_2—N_2O. It has been assumed that a spherically symmetric potential of the form $V(r) = 4\epsilon[(\sigma/r)^{12} - (\sigma/r)^6]$ may be used and that the dynamics of the diffusion process are adequately described by the classical Chapman–Enskog transport relations, which consider only elastic, binary collisions. The potential parameters derived from diffusion measurements have been compared with those obtained from measurements of viscosity, compressibility, the critical temperature and the critical volume. It was not possible, for either system, to obtain a single set of parameters which could satisfactorily reproduce all the gaseous properties. It has been concluded that, for the present systems, the failure is due to one or both of the following: (1) inadequacy of the assumed potential form, (2) importance of inelastic collisions. A.

539.132

350. The dissociation energy of the C–I bond in methyl iodide from electron impact measurements. C. A. MCDOWELL AND B. G. COX. Letter in *J. chem. Phys.*, **20**, 1496–7 (*Sept.*, 1952).

$D(CH_3—I)$ has been evaluated to be $52·6 \pm 2·3$ kcal/mole from the determined $V(CH_3^+)$ and known $I(CH_3)$, this value being in good agreement with the lowest value so far known in literature. Other experiments have shown that $D(CH_3—H) - D(CH_3—I) = 48·5 \pm 0·5$ kcal/mole, hence $D(CH_3—H)$ is $101·3 \pm 2·4$ kcal/mole, also in good agreement with the available data. F. LACHMAN

539.132

351. On the calculation of the polarization energy of halogen–hydrogen molecules. J. I. HORVÁTH. *Z. Phys.*, **132**, *No.* 5, 565–8 (1952) *In German.*

An improvement over the Gombás–Neugebauer method is achieved. The polarization energy is calculated additively from those of individual closed electron shells of the Cl^- anion. This brings binding

energy and internuclear distance into closer agreement with experimental results. J. JACOBS

539.132

352. The energy of dissociation of Hg_2. J. G. WINANS AND M. P. HEITZ. *Z. Phys.*, **133**, *No.* 1–2, 291–6 (1952).

A new measurement of the energy of dissociation of Hg_2 was made under conditions avoiding some possible errors in previous determinations. The value obtained was $0{\cdot}071 \pm 0{\cdot}002$ V in agreement with previous measurements. It is pointed out that this is the dissociation energy for an average rotational energy about equal to the dissociation energy. The dissociation energy for a non-rotating molecule was determined to be $D_0 = 0{\cdot}121 \pm 0{\cdot}01$ V. This agrees with $D_0 = 0{\cdot}123$ V calculated from London's equation. A.

539.132

353. Approximate treatment of the effect of centrifugal distortion on the rotational energy levels of asymmetric-rotor molecules. D. KIVELSON AND E. B. WILSON, JR. *J. chem. Phys.*, **20**, 1575–9 (*Oct.*, 1952).

A first-order treatment yields the relation

$$W = W_0 + A_1 W_0^2 + A_2 W_0 J(J+1) + A_3 J^2(J+1)^2 + A_4 J(J+1)\langle \mathbf{P}_z^2 \rangle + A_5 \langle \mathbf{P}_z^4 \rangle + A_6 W_0 \langle \mathbf{P}_z^2 \rangle$$

for the rotational energy W of a non-rigid asymmetric rotor. The A's are constants independent of the rotational quantum numbers (J, K_{-1}, K_{+1}) while W_0 is the rigid-rotor energy. $\mathbf{P}_z$ is the operator for the component of angular momentum along the axis of quantization. Formulae are given for $\langle \mathbf{P}_z^2 \rangle$ and $\langle \mathbf{P}_z^4 \rangle$, based on continued fractions, as well as expansions useful for nearly symmetric cases. As a special case, the corrections are derived for transitions between the components of asymmetry doublets. A.

539.132

354. Selection rules for vibrational spectra of linear molecules. S. M. FERIGLE AND A. G. MEISTER. *Amer. J. Phys.*, **20**, 421–8 (*Oct.*, 1952).

An elementary explanation is given of the group theory method using characters to determine the selection rules for the fundamental vibrations of a linear polyatomic molecule. Then the method is extended to indicate how the selection rules for the overtones and summation and difference tones are obtained. Finally, the procedure for determining the number of fundamental frequencies belonging to a particular vibration type is given. The groups $C_{\infty v}$ and $D_{\infty h}$ are used as examples in the treatment since they are the only ones involved in the consideration of linear molecules. A.

539.132

355. Influence of σ electrons on the lower excited electronic levels of benzene. K. NIIRA. Letter in *J. chem. Phys.*, **20**, 148–9 (*Sept.*, 1952).

Hückel's functions are assumed for the π-electrons and sp^2 hybridized orbitals for the σ-electrons. Subject to neglect of some overlap and three- and four-centre integrals the exchange energy between π- and σ-bonds is calculated ($-20{\cdot}71$ eV for the ground state), and this is taken into account for the evaluation of the energy levels of the molecule. From the considerable difference between these values and previous results it is concluded that in close approximations the influence of the σ-electrons cannot be neglected. A. J. TAYLOR

539.132

356. Spin-spin interaction in HD nuclear resonance. B. SMALLER, E. L. YASAITIS, E. C. AVERY AND D. A. HUTCHISON. Letter in *Phys. Rev.*, **88**, 414 (*Oct.* 15, 1952).

The fine structure expected on the basis of Ramsey and Purcell's theory [Abstr. 2884 (1952)] was observed only as a broadening of the resonance line. With an *a priori* postulation of the structure, the component separation comes to 52 ± 6 c/s. L. PINCHERLE

539.132

357. Interaction between nuclear spins in HD gas. H. Y. CARR AND E. M. PURCELL. Letter in *Phys. Rev.*, **88**, 415 (*Oct.* 15, 1952).

Field independent fine structure in both the H and D nuclear resonances of HD were observed, in agreement with Ramsey and Purcell's [see Abstr. 2284 (1952)] theoretical results derived from the assumption of an indirect spin-spin coupling of the nuclei via the electrons of the molecule. A method of observation similar to Hahn's [Abstr. 4268 (1950), 2922 (1951)] was employed. The observed separation between the three components of the H resonance was found to be $43{\cdot}5 \pm 1$ c/s. L. PINCHERLE

539.132

358. Two-center heteronuclear hybrid Coulomb-exchange integrals. R. O. BRENNAN AND J. F. MULLIGAN. *J. chem. Phys.*, **20**, 1635–44 (*Oct.*, 1952).

The method introduced by Sklar and Lyddane, and used by Parr and Crawford, to evaluate two-centre hybrid Coulomb-exchange integrals involving atoms with equal effective nuclear charges has been extended to include the case of unequal effective nuclear charges. Formulae for all thirty non-vanishing integrals of this type involving $2s$ and $2p$ Slater atomic orbitals (assuming that the $2s$ and $2p$ orbitals on the same atom have the same screening) are given in a form convenient for numerical calculations. These formulae are valid for both the homonuclear and the heteronuclear cases. The method here given has the advantage that all the integrals are expressed in terms of natural logarithms, exponentials and exponential integrals, adequate tables of which are readily available. Exact numerical values obtained by this method for thirty hybrids involving carbon and oxygen atomic orbitals in CO_2 are given. These exact values have been used as a check on the validity of an approximation previously employed for these integrals. A.

539.132

359. A method for estimating electronic repulsion integrals over LCAO MO's in complex unsaturated molecules. R. G. PARR. Letter in *J. chem. Phys.*, **20**, 1499 (*Sept.*, 1952).

The method is approximate: all $2p\pi$ atomic orbitals are assumed to be orthogonal, and the actual π orbital charge distribution is replaced by two tangent spherical distributions. A value for the effective nuclear charge, slightly different from the usual value, must also be assumed. For benzene the results agree well with those of exact evaluations. A. J. TAYLOR

539.132

360. Free electron wave functions as approximations to MO wave functions for conjugated molecules. H. H. JAFFÉ. Letter in *J. chem. Phys.*, **20**, 1646 (*Oct.*, 1952).

The free electron model (FEM) can be used for the calculation of spectra of conjugated molecules. Although energies found thus do not agree closely with those found by the MO method, the symmetry characteristics are identical. The FEM leads to an infinite number of wave functions, which are only found by MO if excited orbitals are included. There is good agreement between FEM and MO for acyclic compounds; the wave functions found for the radical $CH_2{=}CH{-}CH{=}CH{-}CH_2$ are plotted. Both methods also agree for chains with hetero atoms. Electron densities, bond orders and free valences can be calculated easily by FEM. In cyclic molecules this is more difficult. A. J. TAYLOR

539.132

361. Molecular orbital theory of reactivity in aromatic hydrocarbons. H. H. GREENWOOD. Letter in *J. chem. Phys.*, **20**, 1653 (*Oct.*, 1952).

It is suggested that aromatic reactions are not associated in particular with the least bound electron pair of the π-electron system as proposed by Fukui *et al.* [Abstr. 5335 (1952)]. For electrophilic reactions the π-electron pair occupying the deepest energy level tends to be localized at the position of attack.

H. H. GREENWOOD

539.132

362. Theory of absorption spectra of carotenoids according to Tomonaga-gas model of π-electrons. G. ARAKI AND T. MURAI. Letter in *J. chem. Phys.*, **20**, 1661–2 (*Oct.*, 1952).

First excitation energies for carotenoid molecules have been calculated, taking account of electron interactions. For long carotenoids these Coulomb interactions are large. J. JACOBS

539.132 : 541.127

363. Theoretical considerations concerning Hammett's equation. III. σ-Values for pyridine and other aza-substituted hydrocarbons. H. H. JAFFÉ. *J. chem. Phys.*, **20**, 1554–5 (*Oct.*, 1952).

For Pt II, see Abstr. 5237 (1952). Electron distributions in pyridine, pyrimidine, quinoline, isoquinoline, acridine, phenazine and phenanthridine have been calculated by the LCAO MO method, and used to calculate Hammett's σ-values for the different positions in these compounds. The values are compared with the experimental values available for pyridine, quinoline and isoquiniline, and satisfactory agreement is obtained. Formulae are given for the calculation of σ-values of similar compounds. A.

539.132 : 541.651

364. Study of a fundamental ion in the series of oxazines. J.-L. MASSE. *C.R. Acad. Sci.* [*Paris*] **235**, 575–7 (*Sept.* 15, 1952) *In French.*

The colouring skeleton of the series of oxazines is investigated theoretically: the simple MO(LCAO) method is used. Overlap integrals are neglected as well as resonance integrals between non-nearest neighbours. The Coulomb and resonance integrals for the nitrogen and oxygen atoms are expressed as linear functions of those for carbon. The energy levels, charges, bond-orders, and free valences are tabulated. The wavelength of the transition to the first excited level is found to be 6610Å. This agrees well with experimental values (6500Å, 6560Å).

A. J. TAYLOR

539.133

365. Disproportionation in deuterated ammonia. J. BIGELEISEN. Letter in *J. chem. Phys.*, **20**, 1495–6 (*Sept.*, 1952).

Calculations based on the results obtained by Stedman [Abstr. 5238 (1952)] from quantitative determination of the amounts of NH_3, NH_2D, NHD_2 and ND_3 in a sample of deuterated ammonia are discussed. G. I. W. LLEWELLYN

539.133

366. Evidence for a completely planar structure of pyrrole from its microwave spectrum. W. S. WILCOX AND J. H. GOLDSTEIN. Letter in *J. chem. Phys.*, **20**, 1656–7 (*Oct.*, 1952).

For the planar structure, nuclear spin statistical weight factors enter the computation of the relative intensities of rotational absorption lines. These factors are different for lines arising from levels symmetric and antisymmetric in the nuclei, leading to different computed intensities. The observed intensities are approximately in the same ratio. A non-planar structure would predict equal intensities.

H. H. GREENWOOD

539.133

367. Molecular structure of bromoform. Q. WILLIAMS, T. COX AND W. GORDY. *J. chem. Phys.*, **20**, 1524–5 (*Oct.*, 1952).

The structure of bromoform has been evaluated entirely from microwave spectroscopy. The B_0 values in Mc/s of the isotopic species studied are: $1247{\cdot}61 \pm 0{\cdot}025$ for $CHBr_3^{79}$; $1217{\cdot}30 \pm 0{\cdot}025$ for $CHBr_3^{81}$; $1239{\cdot}45 \pm 0{\cdot}025$ for $CDBr_3^{79}$; $1209{\cdot}51 \pm 0{\cdot}025$ for $CDBr_3^{81}$. These constants yield the structure as follows: $d_{CH} = 1{\cdot}07$Å $\pm 0{\cdot}01$Å, $d_{CBr} = 1{\cdot}930$Å $\pm 0{\cdot}003$Å, angle BrCBr $= 110° 48' \pm 16'$. A.

539.133

368. Bond moments and induced moments. P. T. NARASIMHAN. Letter in *Curr. Sci.*, **21**, 181–2 (*July*, 1952).

The calculation of induced moments in non-polar parts of a molecule due to induction from a primary dipole involves an estimate of the volume δV of the atoms. A correction in δV is suggested which excluded any "free space." J. JACOBS

539.133

369. Rotational magnetic moment, magnetic susceptibilities, and electron distribution in the hydrogen molecule. N. J. HARRICK AND N. F. RAMSEY. *Phys. Rev.*, **88**, 228–32 (*Oct.* 15, 1952).

Measurements have been made on the rotational spectrum of H_2 in the state $I = J = 1$ and in strong external magnetic fields. These measurements yield a value for the rotational magnetic moment of H_2 in the rotational state $J = 1$ of $\mu_{RH} = (0{\cdot}88291 \pm 0{\cdot}00007)$ nuclear magnetons. From this, the high frequency contribution to the diamagnetic susceptibilit is calculated to be $\xi_{HF} = (1{\cdot}64 \pm 0{\cdot}16) \times 10^{-31}$ erg gauss^{-2} molecule^{-1}. Since the diamagnetic interaction with the external field increases as the

square of the field, the high field measurements yield accurate determinations of the dependence of the diamagnetic susceptibility on the molecules' orientations which is found to be $\xi_{\pm 1} - \xi_0 = -(3{\cdot}66 \pm 0{\cdot}20) \times 10^{-31}$ erg gauss^{-2} molecule^{-1}. ξ_{HF} and $\xi_{\pm 1} - \xi_0$ may be combined to give a measure of the quadrupole moment of the electron distribution relative to the internuclear axis with the result that $Q_e^{expt} = (0{\cdot}330 \pm 0{\cdot}013) \times 10^{-16}$ cm^2. A.

539.133

370. Solutions of some problems concerning long random coils. C. A. HOLLINGSWORTH. *J. chem. Phys.*, **20,** 1580–90 (*Oct.*, 1952).

The problem of random flights in boundary value form is used to determine certain probabilities related to the probability that a long random coil passes within a given distance of one or more given points. A.

539.133

371. On the statistical theory of crystallite length. R. SIMHA. Letter in *J. chem. Phys.*, **20,** 1654 (*Oct.*, 1952).

Comments on the statistical results obtained by Dole *et al.* [Abstr. 5086 (1952)] in their thermodynamical investigation of solid polyethylene and, in particular, in the study of the size distribution of sequences between branch points of this polymer.

F. LACHMAN

539.133 : 535.343–15

Infra-red dichroism and protein structure. Infra-red dichroism of tobacco mosaic virus nucleoproton. *See Abstr.* 126

ATOMIC STRUCTURE . NUCLEUS ISOTOPES 539.15

539.152.1

372. Note on the energy levels of light nuclei. F. J. WIŚNIEWSKI. *C.R. Acad. Sci.* [*Paris*] **235,** 364–5 (*Aug.* 4, 1952) *In French.*

The excitation energies of some of the levels of certain light nuclei (Li^7, Be^8, B^{10}, B^{11}, C^{11}, C^{12}, C^{13}) are shown to satisfy an equation $E = Kn(n + 1)$, with K constant for a given nuclide, and n integral; these may therefore be rotational levels. For B^{10} and C^{13} there are two series with different K; it is suggested that there may be two different forms of these nuclides. A. O. STANESBY

539.152.1

373. α-Energy systematics and proton shells for heavier nuclei. S. SENGUPTA. Letter in *Phys. Rev.*, **87,** 1136–7 (*Sept.* 15, 1952).

A plot of E_α against Z for $N = 130$, 131, 132, 134, 136, 138, 142, 144, reveals, in addition to the $Z = 82$ shell, discontinuities at $Z = 92$ (0·7 MeV) and $Z = 88$ (0·5 MeV) which may indicate that the 4 protons between 88 and 92 go into the $3p_{3/2}$ level.

W. J. SWIATECKI

539.152.1

374. A theoretical attempt to predict the excited states of nuclei in the neighbourhood of ^{208}Pb. M. H. L. PRYCE. *Proc. Phys. Soc.* [*London*] *A*, **65,** 773–90 (*Oct.*, 1952).

Pb^{208} has a double closed shell of 82 protons and 126 neutrons. The classification of the lowest excited states of Pb^{207}, Tl^{207}, Pb^{209}, Bi^{209}, which differ by one nucleon, should thus follow the single-particle model closely. The attempt is made to classify the lowest excited states of Pb^{206}, Tl^{206}, Hg^{206}, Pb^{210}, Bi^{210} and Po^{210}, which differ by two particles, in terms of the one-particle model, taking the interaction of the two particles as a perturbation. Considerable uncertainties in the order of the energy levels remain, but some definite conclusions are possible. The existence of an isomeric state of Bi^{210} (RaE) with very high spin ($I = 8$?) is predicted. This fits in with known facts about the α-particle-emitting isomeric state. The method can also be applied to Tl^{208}, Bi^{208} and the excited states of Pb^{208} which arise by lifting one nucleon into the next shell, leaving a hole. It meets with considerable success for Tl^{208}. Discrepancies with known facts in the case of Pb^{208} suggest a more complex picture, according to which the first excited state would have $I = 0$ and even parity. Such a state has never been observed, but its existence is not completely excluded by observation. A.

539.152.1

375. Discontinuities in the binding energies of neutrons and protons in light nuclei. M. G. REDLICH. *Phys. Rev.*, **88,** 38–9 (*Oct.* 1, 1952).

Apart from even-odd variations, there is a peak in the binding energies of neutrons at $N = 7$, and of protons at $Z = 7$. Smaller peaks may exist at N or $Z = 11$ and 14. A.

539.152.1

376. A further test of the shell model. J. S. KING AND W. C. PARKINSON. Letter in *Phys. Rev.*, **88,** 141, (*Oct.* 1, 1952).

Experiments on the angular distribution of the protons associated with the ground state in the reaction $Cl^{35}(d, p)Cl^{36}$ indicate that the neutron carries mainly two units of orbital momentum into the residual nucleus and is presumably a $d_{3/2}$ nucleon as required by the shell model. L. PINCHERLE

539.152.1

377. Radii of mirror nuclei. R. R. WILSON. *Phys. Rev.*, **88,** 350–1 (*Oct.* 15, 1952).

A nuclear model is used in which the nucleon density is a constant out to the core radius R and then decreases as $e^{-\alpha r}/r^2$, where $\alpha^2 = 8MW/\hbar^2$, in which W is taken as the average binding energy per nucleon. Values of R are determined from the measured energy differences between mirror nuclei by calculating the Coulomb energy difference on the above model. If one assumes that the density of the core is constant with changing A, then $R = 1{\cdot}36 \times 10^{-13} A^{\frac{1}{3}}/(1 + 3/\alpha R)^{\frac{1}{2}}$ and fits the data well. This also gives values of nuclear radii in agreement with those obtained from the recent electron scattering measurements of Lyman, Hanson and Scott even for large A. For light elements, a good approximation to the average nuclear radius, $R + 1/\alpha$, is $1{\cdot}4 \times 10^{-13} A^{\frac{1}{3}}$. Nearly half of the nucleons are in the exponential tail. A.

539.152.2

378. The nuclear electric quadrupole moment of erbium 167. G. S. Bogle, H. J. Duffus and H. E. D. Scovil. Letter in *Proc. Phys. Soc.* [*London*] *A*, **65**, 760–1 (*Sept.*, 1952).

Bleaney and Scovil's paramagnetic resonance measurements [Abstr. 4533 (1951)] have been extended to 4°K at 3 cm. Because of the larger spin-lattice relaxation time at this temperature, the spectrum is completely resolved in all directions. From the splitting of quadrupole lines ($\Delta m = \pm 2$) the nuclear electric qudrupole moment was found to be $(10{\cdot}2 \pm 3)10^{-24}$ cm^2. L. PINCHERLE

539.152.2

379. Nuclear magnetic resonance experiment on a four-proton system in a single crystal of $K_2HgCl_4.H_2O$. J. Itoh, R. Kusaka, Y. Yamagata, R. Kiriyama and H. Ibamoto. Letter in *J. chem. Phys.*, **20**, 1503–4 (*Sept.*, 1952).

539.152.2

380. Nuclear spin of V^{50} by paramagnetic resonance. C. Kikuchi, M. H. Sirvetz and V. W. Cohen. Letter in *Phys. Rev.*, **88**, 142 (*Oct.* 1, 1952).

The lines for $m = \pm 7$ were not observed, though conditions were such that they would have been observed if present. Thus it is concluded that the spin of V^{50} is 6, in disagreement with Nordheim's rule—which would indicate spin 7—but in agreement with shell-theoretical calculations [see Abstr. 8396 (1952)]. L. PINCHERLE

539.152.2 : 548.7

381. Nuclear electric quadrupole spectra in solids. R. Bersohn. *J. chem. Phys.*, **20**, 1505–9 (*Oct.*, 1952).

Recent experiments have demonstrated the feasibility of observing nuclear electric quadrupole interactions of widely varying magnitudes in solids. While these effects can often be observed in powdered samples, the most complete information is obtainable from the Zeeman pattern of a single crystal. To facilitate interpretation of these experiments, the nuclear spin energy levels are derived for different relative magnitudes of quadrupole interaction and external magnetic field. Besides the knowledge of the gradient of the electric field tensor, in principle, low frequency molecular rotation should be detectable by means of the quadrupole spectra. A.

539.153

382. Term values in the F^3 electron configuration. G. Racah. Letter in *Curr. Sci.*, **21**, 67 (*March*, 1952).

Some discrepancies between previous results (Racah, 1942) and work by V. Ramakrishna Rao [Abstr. 5206 (1950)] whose results are based on Slater's method, are explained. A. J. TAYLOR

539.153

383. Strong coupling in inelastic collisions of electrons with atoms. H. S. W. Massey and C. B. O. Mohr. *Proc. Phys. Soc.* [*London*] *A*, **65**, 845–53 (*Oct.*, 1952).

The various approximations which have been used to calculate the probability of excitation of an atom by impact with an electron whose energy is not greatly in excess of the threshold are known to fail under certain conditions. This is especially true in the important cases in which the excitation proceeds mainly through electron exchange. In these cases the exchange coupling is too strong for approximate methods, which assume weak coupling, to be valid. By using a schematic model exact solutions for strong exchange coupling are obtained and compared with the results of different weak coupling approximations. It is found that the Born–Oppenheimer approximation is never reliable at low electron energies but if distortion of the incident and scattered waves by the atomic field is allowed for correctly, much better results may be obtained. A.

539.153

384. Natural line shape. F. Low. *Phys. Rev.*, **88**, 53–7 (*Oct.* 1, 1952).

The covariant methods of Feynman and Dyson are applied to the problem of line shape. It is shown that the line centre depends almost completely on the form of the $S_{Fe'}$ function, that is the Feynman-type Green's function for the electron interacting with an external field A^e_μ and with the quantized radiation field. A finite equation for $S_{Fe'}$ is derived, from which the line centre and shape may be calculated to any desired accuracy. The method is illustrated by two examples: the elastic scattering of photons by a one-electron atom in its ground state and the emission of photons by the same type of atom following thermal excitation. A.

539.153

385. The hyperfine structure of hydrogen and deuterium. A. G. Prodell and P. Kusch. *Phys. Rev.*, **88**, 184–90 (*Oct.* 15, 1952).

The hyperfine structure separations, ν_H and ν_D of the ground states of H and D have been measured by the atomic beam magnetic resonance method. In both cases the determination depends essentially on a measurement with high precision of the frequency of a very nearly field-independent line at weak fields and the measurement with reduced precision of the frequencies of one or more field-dependent lines. The design of the apparatus and the conditions under which the experiment was performed were such as to permit the accumulation of a large body of significant data and the determination of precise values for the h.f.s. separations by statistical analysis of the data. It is found that $\nu_H = (1420{\cdot}4051 \pm 0{\cdot}0002) \times 10^6$ sec^{-1}, $\nu_D = (327{\cdot}38424 \pm 0{\cdot}00008) \times 10^6$ sec.$^{-1}$ From these results and the very accurately known ratio of the proton and deuteron magnetic moments, it is found that $\Delta = (1{\cdot}703 \pm 0{\cdot}008) \times 10^{-4}$, where $(\nu_H/\nu_D)_{exp} = (\nu_H/\nu_D)[1 - \Delta]$ and (ν_H/ν_D) is calculated from the ratio of the magnetic moments of the proton and deuteron under the assumption that these particles are point dipoles which interact with the electronic magnetic field. A.

539.153

386. Perturbations of atomic g values. M. Phillips. *Phys. Rev.*, **88**, 202–5 (*Oct.* 15, 1952).

A further investigation of the perturbation by excited core states of gyromagnetic ratios for atoms consisting of a single electron outside closed shells takes account of the spin/orbit interaction of the excited core. Although the effect vanishes to lower orders than the fourth, and at least the first term in the expansion of the electrostatic interconfiguration interaction cancels even in that order, there is for

alkali atoms a residual correction possibly large enough to account for observed deviations of g values from those expected. Calculations have also been made for ^2P states: The effect in Ga is negligible, but the anomalous observed $g_J(P_{3/2})/g_J(P_{1/2})$ for In may be at least in part due to perturbations of this kind. A.

539.153 : 537.122

387. The anomalous magnetic moment of the electron. S. H. KOENIG, A. G. PRODELL AND P. KUSCH. *Phys. Rev.*, **88,** 191–9 (*Oct.* 15, 1952).

The ratio of the electron spin g value and the proton g value has been measured with high precision. It is found that $g_s/g_p = 658{\cdot}2288 \pm 0{\cdot}0006$, where g_p is the g value of the proton measured in a spherical sample of mineral oil. This result, when combined with the measurement by Gardner and Purcell of the ratio of the electron orbital g value and the proton g value, yields for the experimental value of the magnetic moment of the electron $\mu_s = (1{\cdot}001146 \pm 0{\cdot}000012)\mu_0$. The result is in excellent agreement with the theoretical value recently calculated by Karplus and Kroll: $\mu_s = (1{\cdot}0011454)\mu_0$. A.

539.153 : 537.122

388. A determination of $g_J(^2S_{\frac{1}{2}})$ of potassium in terms of the proton gyromagnetic ratio. P. FRANKEN AND S. KOENIG. *Phys. Rev.*, **88,** 199–201 (*Oct.* 15, 1952).

The ratio of the g value of potassium K^{39} in the ground state to the gyromagnetic ratio of the proton in mineral oil has been measured in an experiment combining atomic beam and nuclear resonance techniques. It is found to be $g_J(K)/g_p = 658{\cdot}2274 \pm 0{\cdot}0023$. This result, when combined with the measurement of $g_J(H)/g_p$ by Koenig, Prodell and Kusch (preceding abstract), yields $g_J(K)/g_J(H) = 1{\cdot}000016 \pm 0{\cdot}0004\%$. This is to be compared with the recent direct measurement by Pohlman, Bederson and Eisinger: $g_J(K)/g_J(H) = 1{\cdot}00016 \pm 0{\cdot}006\%$. The present experiment is of superior precision and is in agreement with independent experimental evidence. The present result is found to agree with the theoretically predicted value. A.

539.153.4 : 537.533.74

389. The exchange scattering of an electron by an atom and inverse Auger effect. T.-Y. WU. *Phys. Rev.*, **87,** 1012–15 (*Sept.* 15, 1952).

The theory of exchange scattering of an electron by an atom given by Mott and Massey (1949) is discussed. A new formulation of an approximate treatment of the problem is suggested that leads to a system of differential integral equations similar to the Fock equations for the discrete state of atoms. This method leads to Oppenheimer's result as a first approximation. The resonance scattering arising from the inverse process of auto-ionization (Auger effect) is treated in a phenomenological manner. A.

539.155.2

390. Calutron charge materials for stable-isotope separation. C. P. KEIM. *Nucleonics*, **10,** 29–31 (*Aug.*, 1952).

The procedure adopted in electromagnetic isotope separators is outlined very briefly. A list of the best charge materials for various isotopes, and suitable operating conditions, is given. L. R. SHEPHERD

539.155.4

391. The mass of Cl^{39} and of A^{39}. C. E. ANDERSON, G. W. WHEELER AND W. W. WATSON. Letter in *Phys. Rev.*, **87,** 897–8 (*Sept.* 1, 1952).

No ground-state proton group was observed in $A^{38}(d, p)A^{39}$, although a Q value > 5 MeV would have been detected; there were no γ-rays in coincidence with the A^{39} β-decay. The mass of $A^{39}(38{\cdot}97667 \pm 4)$ obtained from K^{39} and the β-energy gives $Q = 4{\cdot}31$ MeV. Disintegration data then gives $Cl^{39} = 38{\cdot}98022 \pm 13$, in disagreement with Wilkinson and Carver [Abstr. 8908 (1951)], whose result implies that $Q = 5{\cdot}92$ MeV, and Haslam *et al.* [Abstr. 1996 (1951)]; both contradict the observed β-decay energy of A^{39}. T. G. PICKAVANCE

539.155.4 : 541.23

392. A comparison of the chemical and physical atomic weight values of the monoisotopic elements. A. F. SCOTT AND M. BETTMAN. *Chem. Rev.*, **50,** 363–74 (*June*, 1952).

Attempts to compare systematically the values for the twenty-two elements which are known to be composed of only one stable isotope. It is found that of this group there are only five elements whose atomic weight values on both the chemical and the physical scales deserve the highest confidence. It is concluded that these data are too limited to permit a significant comparison of the two atomic weight scales to be carried through. Attention is directed to the question of the atomic weight of Ag, because this constant is the practical basis of many chemical atomic weight values; here also no unqualified conclusion can be drawn. A.

RADIOACTIVITY . α-, β- AND γ-RAYS 539.16

539.16.08

393. Radiometric properties of the thorium series. J. FRESCO, E. JETTER AND J. HARLEY. *Nucleonics*, **10,** 60–4 (*Aug.*, 1952)

Equations and graphs are given, expressing the α- and β-activities as a function of time following the isolation of one or more of the isotopes in the thorium series. The application of these equations to the analysis of thorium products by α- or β-counting is outlined. An expression is derived for the surface dose-rate due to β-particles escaping from a semi-infinite uniform source. By way of example the results are applied to the calculation of surface dose-rate for thorium metal at equilibrium and three years after separation. L. R. SHEPHERD

539.162 : 539.166 : 530.145

394. The interference of amplitudes in cascade processes. O. HALPERN AND B. A. LIPPMANN. Letter in *Phys. Rev.*, **87,** 1128 (*Sept.* 15, 1952).

An extension of Abstr. 3719 (1951) to eliminate certain complications arising in the case of a polarized initial state, and to prove that in the most general cascade process a description can always be introduced according to which each step of the cascade leads to one and only one "causal" intermediate state.

A. O. STANESBY

539.163.1

395. Half-lives of Eu^{152}, Eu^{154}, and Sm^{151}. D. G. KARRAKER, R. J. HAYDEN AND M. G. INGHRAM. Letter in *Phys. Rev.*, **87**, 901 (*Sept.* 1, 1952).

The change with time of the isotopic constitution of samples containing the nuclide under investigation, measured by mass-spectrographic methods, gives the $\frac{1}{2}$-life directly: Eu^{152}, 13 ± 2; Eu^{154}, 16 ± 4; Sm^{151}, 73^{+25}_{-14} yr. A. O. STANESBY

539.163.2

396. Disintegration of Cr^{51}. W. S. LYON. Letter in *Phys. Rev.*, **87**, 1126 (*Sept.* 15, 1952).

The radiations of Cr^{51}, which decays by orbital electron capture, were investigated using coincidence counting, X-ray counting, and NaI crystal spectrometry: the branching ratio e^-/X-ray is $3{\cdot}0 \times 10^{-4}$; only one γ-ray (0·32 MeV) was observed, with an intensity 0·08 of disintegrations; the $\frac{1}{2}$-life is $27{\cdot}75 \pm 0{\cdot}3$ days. A. O. STANESBY

539.163.2

397. Radioactive decay of indium 114. M. W. JOHNS, C. D. COX, R. J. DONNELLY AND C. C. MCMULLEN. Letter in *Phys. Rev.*, **87**, 1134–5 (*Sept.* 15, 1952).

β- and γ-radiations were examined in a Siegbahn type β-spectrometer of 50 cm radius; a decay scheme is suggested. A. O. STANESBY

539.163.2

398. Some experiments on Ge^{75} and Ge^{75m}. A. B. SMITH, R. S. CAIRD AND A. C. G. MITCHELL. Letter in *Phys. Rev.*, **88**, 150 (*Oct.* 1, 1952).

The β- and γ-spectra of Ge^{75} were investigated using magnetic lens and scintillation spectrometers, and coincidence counting techniques. An isomer of Ge^{75}, with a $\frac{1}{2}$-life of 48 ± 2 sec and an excitation energy of 0·175 MeV was obtained by $Ge^{74}(n, \gamma)$ and $As^{75}(n, p)$ reactions [see also Abstr. 7503 (1952)]. A. O. STANESBY

539.164

399. On the knowledge about new α-rays occurring in nature. A. BRUKL, F. HERNEGGER AND H. HILBERT. *S.B. Österr. Akad. Wiss. IIa*, **160**, *No.* 6–10, 129–216 (1951) *In German.*

Using a tube electrometer with a large time-constant new α-rays were found in samples from Zn ores. The activities could be enriched by chemical treatment. Ranges in air: 0·9, 1·3, 1·79, 2·28, $2{\cdot}76 \pm c.\ 0{\cdot}08$ cm. W. J. SWIATECKI

539.164

400. The alpha-particles of radium. F. ASARO AND I. PERLMAN. *Phys. Rev.*, **88**, 129–31 (*Oct.* 1, 1951).

The abundance of α_{188} of Ra^{226} was determined with an α-particle spectrograph to be $5{\cdot}7 \pm 0{\cdot}3\%$. (The nomenclature α_{188} refers to the α-group populating the excited level of the residual nucleus which is 188 keV above the ground state.) A limit of 0·1% was determined as the maximum abundance of any α-group in the region 300 to 800 keV below α_0 of Ra^{226}. Ghiorso, utilizing an α-pulse analyser, lowered this limit to 0·02% in the region 400 to 1200 keV below α_0. A.

539.164

401. Geiger–Nuttall relation and α-ray spectra. M. L. CHAUDHURY. Letter in *Phys. Rev.*, **88**, 137 (*Oct.* 1, 1952).

A graph is given of $\log \lambda_k$, where λ_k is the partial decay constant, ν. decay energy E. It is found that for a given complex α-ray spectrum, both increases and decreases of $\log \lambda$ with increasing E occur, instead of the usual Geiger–Nuttall relation. It is suggested that this might be accounted for, if instead of assuming that the field outside the residual nucleus is pure Coulomb, some short-range nuclear interaction between the α-particle and the surface nucleons is introduced. J. HUGHES

539.164.75

402. The range of alpha-particles in water. H. G. DE CARVALHO AND H. YAGODA. *Phys. Rev.*, **88**, 273–8 (*Oct.* 15, 1952).

A photographic method is described for measuring the ranges of α-particles in liquids whose properties are compatible with emulsion sensitivity utilizing a surface deposit of radiocolloid aggregates as point sources of α-radiation. The method has been applied to both water of normal isotopic composition and to heavy water containing 97% deuterium oxide. Using polonium radiocolloids as a source of 5·3-MeV α-particles ranges of $38{\cdot}1 \pm 0{\cdot}5$ and $38{\cdot}0 \pm 0{\cdot}5$ microns were measured in the respective liquids. By conducting the exposure at temperatures below the freezing point the method is also applicable to certain solid media. The ranges of RaF α-particles in normal and heavy ice were found to be $41{\cdot}6 \pm 0{\cdot}5$ and $41{\cdot}5 \pm 0{\cdot}5$ microns. The integral molecular stopping power of water is computed to be $1{\cdot}56 \pm 0{\cdot}02$ for an α-particle energy of 5·3 MeV. Similar measurements with radium sulphate radiocolloids indicates a molecular stopping power of $1{\cdot}56 \pm 0{\cdot}02$ for the α-particles from RaC′, as compared with a computed value of $1{\cdot}54 \pm 0{\cdot}02$. Larger estimates for this constant may originate from water-air interface effects inherent in experiments with an external detector. A.

539.165/.166

403. Nuclear spectroscopy of Ba^{131}. M. W. ELLIOTT, L. S. CHENG, J. R. HASKINS AND J. D. KURBATOV. *Phys. Rev.*, **88**, 263–5 (*Oct.* 15, 1952).

The spectra of Ba^{131} have been investigated in permanent magnet spectrographs, a solenoidal β-spectrometer and a thin lens γ-spectrometer. γ-Rays of 122, 214, 241, 370 and 494 keV have been confirmed. In the conversion electron spectrum, there is indication of the existence of three low-energy γ-rays: ~65 keV, ~43 keV and ~108 keV. The K/L ratios, K-conversion coefficients and relative intensities have been estimated. A.

539.165/.166

404. The decay of Rh^{106}. D. E. ALBURGER. *Phys. Rev.*, **88**, 339–43 (*Oct.* 15, 1952).

β-Rays with maximum energies of $3{\cdot}53 \pm 0{\cdot}01$, $3{\cdot}1 \pm 0{\cdot}1$, $2{\cdot}44 \pm 0{\cdot}07$ and $2{\cdot}0 \pm 0{\cdot}1$ MeV and relative intensities of 68, 11, 12 and 3% respectively have been found with a lens spectrometer in the decay of Rh^{106}. Internal conversion lines of 0·513 and 0·624 MeV transitions occur with intensities of $7{\cdot}5 \times 10^{-4}$ and $2{\cdot}3 \times 10^{-4}$ relative to total β-emission.

The first of these has a K/L ratio of $7 \cdot 8 \pm 1$, indicating an electric quadrupole radiation. Lens and scintillation spectrometer measurements show that the γ-ray spectrum consists of lines at 0·511, 0·621, 0·87, 1·045, 1·55 and 2·41 MeV with relative intensities of 100 : 53 : 3 : 8 : 2·5 : 1, respectively. The results are consistent with β-decay to states in Pd^{106} at 0, 0·513, 1·137, 1·55 and 2·42 MeV having even parities and spins of 0, 2, 0, 2 and 2, respectively, Rh^{106} is assigned spin 1 and even parity. The possibility of explaining the γ-γ angular correlation of Rh^{106} based on this decay scheme is mentioned. A.

539.165

405. On the measurement of the K/L capture ratio. A. DE-SHALIT. *Bull. Res. Coun. Israel*, **2**, 64 (*June*, 1952).

Describes a method by measuring the coincidence spectrum of Auger electrons, i.e. the number of coincidences which electrons of a given momentum have with all electrons. See Abstr. 421. F. R. HOLT

539.165

406. On the K/β^+ branching ratio of ^{65}Zn. T. YUASA. *C.R. Acad. Sci.* [*Paris*] **235**, 366–8 (*Aug.* 4, 1952) *In French.*

The β^+-spectrum, and the X-ray Auger electron spectrum from the K-capture, of Zn^{65} were measured in a semi-circular focusing magnetic spectrograph, using sources of differing thickness; the total branching ratio K/β^+ is 41 ± 5. The shape of the β^+-spectrum is not that of a simple permitted transition. A. O. STANESBY

539.165

407. A measurement of the L/K capture ratio in ^{79}Kr. P. RADVANYI. *C.R. Acad. Sci.* [*Paris*] **235**, 428–30 (*Aug.* 11, 1952) *In French.*

The nos. of K Auger electron tracks and of isolated L Auger electron tracks were measured in a certain volume of a cloud-chamber containing Kr^{79}. The exptl. ratio of L capture/K capture was calc. as $0 \cdot 27 \pm 0 \cdot 09$; this is much greater than the theoretical value of 0·10 [see Rose and Jackson, Abstr. 3374 (1950)]. A. O. STANESBY

539.165

408. A formulation of beta-decay theory for forbidden transitions of arbitrary order. I. Selection rules and energy spectra. J. A. SPIERS AND R. J. BLIN-STOYLE. *Proc. Phys. Soc.* [*London*] *A*, **65**, 801–8 (*Oct.*, 1952).

The matrix elements of β-decay theory are expressed in a way which not only gives the β-spectra and angular distributions for arbitrary degree of forbiddenness, but also yields very simply the selection rules appropriate to any type of interaction. Results for the energy spectra confirm those found by Greuling by inspection; angular distributions and electron-neutrino correlations are considered in a subsequent paper. A.

539.165

409. A formulation of beta-decay theory for forbidden transitions of arbitrary order. II. Angular distributions. J. A. SPIERS AND R. J. BLIN-STOYLE. *Proc. Phys. Soc.* [*London*] *A*, **65**, 809–14 (*Oct.*, 1952).

The method of Pt I is used to derive general formulae (valid for arbitrary Z) for the angular distributions of β-emissions. A.

539.165 : 550.93

410. K^{40} radioactive decay: its branching ratio and its use in geological age determinations. A. K. MOUSUF. Letter in *Phys. Rev.*, **88**, 150–1 (*Oct.* 1, 1952).

The amount of A obtained from samples of microcline heated with Na *in vacuo* was measured and its isotopic constitution determined mass-spectrographically. The branching-ratio K-capture/β-emission for K^{40} was calc. from the mass ratio A^{40}/K^{40} in the mineral, assuming an average age of $1 \cdot 03 \times 10^9$ yr, and a half-life for K^{40} of $12 \cdot 7 \times 10^8$ yr; the values range from 0·053–0·066 for four samples. A. O. STANESBY

539.165

411. The very long lifetime of C^{14} β-decay. A. M. L. MESSIAH. Letter in *Phys. Rev.*, **88**, 151–2 (*Oct.* 1, 1952).

This cannot be accounted for in terms of existing one-particle models; and the idea of "L-forbiddenness" (assuming the orbital angular momentum L to be a very good quantum number) suggested by Bouchez [Abstr. 547 (1951)] is also shown, by a discussion of several stripping reactions, to be inadequate. A. O. STANESBY

539.165.2

412. The beta-spectrum of He^6. C. S. WU, B. M. RUSTAD, V. PEREZ-MENDEZ AND L. LIDOFSKY. Letter in *Phys. Rev.*, **87**, 1140–1 (*Sept.* 15, 1952).

The end-point, measured in a magnetic solenoidal spectrometer, is $E_{max} = 3 \cdot 50 \pm 0 \cdot 05$ MeV [see also Abstr. 4316 (1950)], and the Kurie plot is linear at least down to 0·6 MeV. The ft value is now 815 ± 70 sec, which is compatible with those of the odd A mirror nuclei, and indicates a greater importance of the Fermi (S or V) interaction in β-decay than was suggested by Moszkowski, using the earlier value of E_{max} [Abstr. 5722 (1951)]. A. O. STANESBY

539.166

413. Angular correlation of gamma-rays in Ti^{48}. P. S. JASTRAM AND C. E. WHITTLE. Letter in *Phys. Rev.*, **87**, 1133–4 (*Sept.* 15, 1952).

The measurements are in good agreement with spin assignments 0–2–4 for the ground and first two excited states of Ti^{48}. The assignment of parities to these, and of spins and parities to the ground states of Sc^{48} and V^{48} is discussed. A. O. STANESBY

539.166

414. The determination of gamma-ray energies from beta-ray spectroscopy and a table of critical X-ray absorption energies. R. D. HILL, E. L. CHURCH AND J. W. MIHELICH. *Rev. sci. Instrum.*, **23**, 523–8 (*Oct.*, 1952).

The significance and limitations of the use of X-ray absorption energies in the determination of γ-ray energies from β-ray spectroscopy are discussed. A complete table of critical X-ray absorption energies, based primarily on the work of Siegbahn, and derived using the 1950 values of the physical atomic constants, is given, with interpolation and extrapolations for elements between $Z = 3$ and $Z = 100$. A.

539.166

415. The angular distribution of γ-radiation from aligned nuclei. N. R. STEENBERG. *Proc. Phys. Soc.* [*Lond.*] *A*, **65**, 791–800 (*Oct.*, 1952).

The angular distribution of γ-radiation from nuclei aligned at low temperature is given as a series of Legendre polynomials, $I(\theta) = 1 + \Sigma_K A_K(T) P_K(\cos\theta)$ the A_K being temperature dependent. The formulation is applicable to cascade processes of arbitrary multipole orders and nuclear spins. An approximation valid for low degrees of alignment is given, as is the angular distribution from completely aligned nuclei. Application is made to Co^{60}. A.

539.166

416. The geometrical correction in angular correlation measurements. E. L. CHURCH AND J. J. KRAUSHAAR. Letter in *Phys. Rev.*, **88**, 419 (*Oct.* 15, 1952).

The corrections are large and dependent on the shape of the resolution curve. A procedure for correcting the data is given. F. R. HOLT

539.166

417. The directional correlations for inelastic scattering with subsequent gamma-radiation. O. HITTMAIR. *Z. Phys.*, **132**, *No.* 5, 559–64 (1952) *In German.*

A general formula is derived and, for the case when the correlation between incident particle and γ is known, the sums over magnetic quantum numbers are evaluated in terms of Racah coefficients under the statistical assumption for the compound nucleus. The application to the scattering of 250 and 350 keV n on Cd^{111} gives information about spins and parities. W. J. SWIATECKI

539.166

418. On inelastic scattering in the continuum theory. O. HITTMAIR. *Z. Phys.*, **132**, *No.* 5, 553–8 (1952) *In German.*

The difficulties in calculating cross-sections in the continuum theory are avoided by consideration of the subsequently emitted γ-ray. The ratio of cross-sections for different bombarding energies but equal γ's does not require the knowledge of the γ-transition probability, but it is essentially spin-dependent. Numerical applications are made to the $^3S_{\frac{1}{2}}$, $^2D_{\frac{5}{2}}$, $^2D_{\frac{3}{2}}$ levels of Cd^{111}. W. J. SWIATECKI

539.166.74

419. The double Compton effect. P. E. CAVANAGH. Letter in *Phys. Rev.*, **87**, 1131 (*Sept.* 15, 1952).

This has been established (with the theoretically expected order of magnitude) by irradiating Be, Al, Cu and Ag foils of various thicknesses with Co^{60} γ-rays and recording scattered γ-γ coincidences. J. J. WILKINS

539.166.83

420. Zero-zero transitions. S. D. DRELL AND M. E. ROSE. Letter in *Progr. theor. Phys.*, **7**, 125–7 (*Jan.*, 1952).

In such transitions the interaction causing internal conversion or pair creation occurs entirely within the nucleus and so the finite nuclear radius governs the transition rates. An estimate for the matrix element $\langle \Sigma r^2_{\text{protons}} \rangle$ is deduced from experiments on RaC′, O^{16} and Ge^{72}. W. J. SWIATECKI

539.166.83

421. The K/L ratio for the 90-keV line of Nd^{147}. A. B. SMITH AND A. C. G. MITCHELL. Letter in *Phys. Rev.*, **87**, 1128 (*Sept.* 15, 1952).

A fission-product (carrier-free) source and a magnetic lens spectrograph were used. The K, L and M lines and an Auger line were resolved. Results were: $K/L = 7{\cdot}55$ and $K/(L+M) = 6{\cdot}88$. F. R. HOLT

539.166.83

422. K-shell conversion coefficient of Ce^{141}. R. L. HEATH. Letter in *Phys. Rev.*, **87**, 1132–3 (*Sept.* 15, 1952).

The ratio of the K X-ray intensity to the 141 keV γ-ray intensity was measured with a NaI crystal, giving $\alpha_K = 0{\cdot}46 \pm 0{\cdot}02$. The K/L conversion ratio (5 ± 1) was also measured, indicating a mixed ($M1$, $E2$) transition, with $M1$ predominating. J. J. WILKINS

539.166.83

423. Internal conversion of the Sr^{88} gamma-rays. F. R. METZGER AND H. C. AMACHER. Letter in *Phys. Rev.*, **88**, 147–8 (*Oct.* 1, 1952).

Measurements in a magnetic lens spectrometer gave values for α_K of 34 ± 7 and $17 \pm 4(\times 10^{-5})$ for the 0·9 and 1·85 MeV γ-rays of Sr^{88}, in agreement with the unpublished values of Peacock and Jones, and the transitions are electric dipole, and magnetic dipole or electric quadrupole resp. Further angular correlation data are required. A. O. STANESBY

539.166.83

424. Internal pair conversion in Mg^{24}. S. D. BLOOM. *Phys. Rev.*, **88**, 312–21 (*Oct.* 15, 1952).

The positron spectra from the internal pair conversion of the two γ-rays following the β^- decay of Na^{24} have been observed, and the internal pair conversion coefficients found to be $7{\cdot}1 \times 10^{-4}$ in the case of the 2·758 MeV γ-ray and $0{\cdot}6 \times 10^{-4}$ in the case of the 1·380 MeV γ-ray. The value of the coefficients and the shape of the spectra lead to the conclusion that both γ-rays are electric quadrupole transitions. A.

539.166.83

425. $K/(L+M)$ internal conversion ratios for $M4$ transitions. G. A. GRAVES, L. M. LANGER AND R. D. MOFFAT. *Phys. Rev.*, **88**, 344–8 (*Oct.* 15, 1952).

A high resolution magnetic spectrometer has been used to study the internal conversion lines of magnetic four-pole transitions. The $K/(L+M)$ internal conversion ratios fall lower than those predicted from the empirical curve of Goldhaber and Sunyar in the region of low values of Z^2/E. A revised curve is presented. The following values are obtained for the energy of the transition and for the $K/(L+M)$ ratio: Y^{91}, 551·2 keV, 6·00; Sr^{87}, 388·2 keV, 5·79; Y^{87}, 381·3 keV, 5·41; Ba^{137}, 661·4 keV, 4·64; In^{113}, 391·7 keV, 4·21; and In^{115}, 334·6 keV, 3·76. Values are also given for lines in Cd^{111} and In^{114}. A.

539.166.83

426. The probability of internal conversion of K-series radiation of Au arising from the interaction of the L sub-shells. J. W. MIHELICH. Letter in *Phys. Rev.*, **88**, 415 (*Oct.* 15, 1952).

Experimental values for the relative probabilities of the Auger transitions were obtained, and compared

with published theoretical results. Agreement is poor; changes in the theory are suggested. F. R. HOLT

539.167.3

427. Techniques related to the production of Fe^{59}. R. W. DUNN. *Nucleonics*, **10**, 40–3 (*Aug.*, 1952).

Further details in the preparation of high specific activity Fe^{59} by the $Co^{59}(d,2p)Fe^{59}$ reaction are given [see also Abstr. 9033 (1952)]. The method of fixing the purified cobalt target metal to the cyclotron probe, its removal after bombardment and the separation of Fe^{59} from $CoCl_2$ solution by ether extraction are described. L. R. SHEPHERD

539.169 : 621.311.29

428. The use of radioactive material for the generation of high voltage. E. G. LINDER AND S. M. CHRISTIAN. *J. appl. Phys.*, **23**, 1213–16 (*Nov.*, 1952).

An investigation has been made of the use of β-emissive radioisotopes for generating high voltages. Voltage was obtained by supporting a β-emitter on an insulated electrode in a low-pressure gas, and allowing it to charge itself by virtue of its electron emission. This method represents a direct conversion of nuclear energy into electrical energy. The apparatus is described. Data on insulation breakdown, the effect of gas pressure and the electrode material are given. The maximum voltage was obtained at a pressure of 10^{-3} mm of Hg. The electrical characteristics of such a generator are discussed. Using an emitter containing 0·25 curie of strontium 90, a voltage of 365 kilovolts was obtained. See also Abstr. 2664 (1946), 1298 (1947). A.

NUCLEAR REACTIONS 539.17

539.172 : 537.591.8

Nuclear reactions due to cosmic rays. *See Abstr.* 301, 310–11

539.172.1

429. The reaction $Li^7(\alpha, \gamma)B^{11}$ and states of B^{11}. G. A. JONES AND D. H. WILKINSON. Letter in *Phys. Rev.*, **88**, 423 (*Oct.* 15, 1952).

Using NaI(Tl) crystals the energies of 12 γ's and several angular correlations were measured leading to 10 levels of B^{11} in the region 0–9·28 MeV whose positions and spins are consistent with the shell model. W. J. SWIATECKI

539.172.13

430. Angular distribution of α-particles from the $Li^7(p, \alpha)He^4$ reaction at low proton bombarding energies. F. HIRST. Note in *Austral. J. sci. Res. A*, **5**, 570–1 (*Sept.*, 1952).

An extension of previous work [Abstr. 490, 1988 (1950), 518 (1952)] in the proton energy range 60–250 keV. The $\cos^2\theta$ coeff., $A(E)$ crosses the zero axis at an energy $\sim$ 100 keV, confirming the participation of f protons in the reaction, on the basis of Inglis's theoretical expression [Abstr. 2938 (1948)]. A. O. STANESBY

539.172.13

431. Artificial activity induced in carbon by fast ^3He ions. J. H. FREMLIN. Letter in *Proc. Phys. Soc. [London] A*, **65**, 762–3 (*Sept.*, 1952).

Experiments with He^3 ions accelerated to 20 MeV in the Birmingham cyclotron are described. Ten-minute and twenty-minute activities produced in a carbon target demonstrated the production of N^{13} and C^{11} respectively. J. H. FREMLIN

539.172.13

432. The absolute determination of resonant energies for radiative capture of protons by beryllium in the energy range below 520 keV. S. E. HUNT. Letter in *Phys. Rev.*, **87**, 902–3 (*Sept.* 1, 1952).

Thin-target yield curves can be closely fitted by two symmetrical Breit–Wigner curves having maxima at $336{\cdot}0 \pm 2$ and $492{\cdot}0 \pm 3$, and $\frac{1}{2}$-widths of 175 ± 5 and 110 ± 5 keV resp. These correspond to excited levels in B^{10} at $6{\cdot}79_1$ and $6{\cdot}93_5$ MeV. A. O. STANESBY

539.172.13

433. Neutron energy distributions from Be, C, and Pb bombarded by 245-MeV protons. B. K. NELSON, G. GUERNSEY AND G. MOTT. *Phys. Rev.*, **88**, 1–8 (*Oct.* 1, 1952).

The energy distribution of the neutrons radiated by targets bombarded by protons of energy 244 MeV has been measured. Neutrons in the forward direction from Be, C and Pb targets were observed, and in a direction 15° forward from Be and C targets. The neutrons were allowed to bombard a polyethylene radiator; scattered protons were observed by a scintillation counter coincidence telescope of four anthracene crystals. The effect of the carbon in the polyethylene was determined by taking similar data with a carbon radiator. The last counter in the telescope was used as a proportional counter, proton energies being determined by measuring the height of the scintillation pulse in this crystal. A gated amplifier, turned on by a coincidence among the four crystals of the telescope, assured that only those pulses in the proportional counter corresponding to protons traversing the telescope from the radiator were counted. The entire neutron spectrum from about 120 to 240 MeV was measured at once by measuring the spectrum of pulses in the proportional crystal with a 24-channel pulse-height analyser. All the spectra observed were found to be peaked, the energies at the peaks being about 215, 195 and 180 MeV for Be, C and Pb, respectively, in the forward direction, and at about 175 and 165 for Be and C at 15°. The carbon and lead spectra were more broadly peaked than the beryllium spectra, and the 15° spectra were broader than the 0° spectra, the full widths at half maximum being 27%, 33% and 49% for Be, C and Pb forward spectra, and 40% and 42% for Be and C at 15°. A.

539.172.13

434. Excitation functions to 100 MeV. N. M. HINTZ AND N. F. RAMSEY. *Phys. Rev.*, **88**, 19–27 (*Oct.* 1, 1952).

A method is described for obtaining excitation functions using the stacked foil technique with an internal cyclotron beam. The method, which utilizes multiple Coulomb scattering for deflection and 180° focusing for energy separation, has the advantages of good energy resolution, high intensity and low background. Equations are presented for the particle orbits from which are derived the energy resolution and efficiency attainable. Absolute excitation curves

are given for the reactions, $C^{12}(p, pn)C^{11}$; Na^{24}, Na^{22} and F^{18} from Al^{27}; $B^{11}(p, n)C^{11}$; and $S^{34}(p, n)Cl^{34}$. Absolute cross-sections are determined using the monitor reaction, $C^{12}(p, pn)C^{11}$, and the ratio of the β-counting rates. Various corrections to the relative and absolute excitation curves are discussed. A brief interpretation of the results is given in which it is argued that they are consistent with present ideas about high-energy nuclear reactions. A.

539.172.13

435. Fission asymmetry as a function of excitation energy of the compound nucleus. J. L. Fowler, W. H. Jones and J. H. Paehler. *Phys. Rev.*, **88**, 71–2 (*Oct.* 1, 1952).

The yield of Mo^{99} and Ag^{111} relative to Ba^{140} has been measured for proton produced fission in normal U. For this type of fission, as well as for fission obtained in other ways, the variation with compound nucleus excitation energy of the ratio of the yield of Ag^{111} to that of Ba^{140} is discussed in terms of the statistical theory of nuclei. A.

539.172.13

436. High energy nuclear reactions and the Goldberger model. J. W. Meadows. Letter in *Phys. Rev.*, **88**, 143 (*Oct.* 1, 1952).

The cross sections for (p, pn), $(p, 2n)$, (p, n), (p, pn) and $(p, 2p)$ processes at 100 MeV in Cu and Zn were calculated, using the techniques of Goldberger for the initial knock-out process, and the statistical theory of Blatt and Weisskopf for the subsequent evaporation.

W. J. Swiatecki

539.172.13 : 537.534.74

Scattering of 31·5 MeV protons from several elements. *See Abstr.* 273

539.172.13 : 537.534.74

437. The Coulomb scattering of deuterium. J. B. French and M. L. Goldberger. Letter in *Phys. Rev.*, **87**, 899–900 (*Sept.* 1, 1952).

The Rutherford formula for deuteron scattering by a Coulomb field is corrected for effects arising from the charge structure of the deuteron. The deviations are negligible for $n = Ze^2/\hbar v \gg 1$, whilst for $n \ll 1$ they agree with Born approximation calculations.

R. H. Dalitz

539.172.13 : 537.534.74

438. The elastic scattering of deuterons by tritons. W. R. Stratton, G. D. Freier, G. R. Keepin, D. Rankin and T. F. Stratton. *Phys. Rev.*, **88**, 257–61 (*Oct.* 15, 1952).

The differential cross-section for the elastic scattering of deuterons by tritons has been measured in the energy range 0·96 MeV to 3·22 MeV. The angular range of data is between 44·3° and 126·4° in the centre-of-mass system of coordinates. The values of the cross-section have a minimum near 90°, and this minimum decreases steadily and moves to higher angles as the incident deuteron energy is increased. At 1·20 MeV the cross-section at the minimum is equal to 0·130 barn, and at 3·22 it is 0·019 barn. A.

539.172.13

439. Deuteron bombardment of Be^9 and classification of levels of B^{10}. F. Ajzenberg. *Phys. Rev.*, **88**, 298–304 (*Oct.* 15, 1952).

Previous measurements on the $Be^9(d, n)B^{10}$ neutron spectrum at 0° and 80° have been extended to 10°, 30° and 45° to check the energy level assignments and to deduce the parity of the levels from a Butler analysis of the angular distributions. The observed neutron groups correspond to levels of B^{10} at 0·72, 1·75, 2·15, 3·53, 4·78, 5·14 (doublet), 5·37 (?), 5·58, 5·72, (?), 5·93, 6·12 (possibly doublet), 6·38, 6·58 and 6·77 MeV. The estimated uncertainty is 0·06 MeV for the first five states of B^{10} and 0·04 MeV for the higher energy levels. The Butler analysis of the angular distribution data indicates that the ground state and the first four excited states of B^{10} are of even parity and that both components of the 5·14-MeV doublet are probably odd parity states. Parity assignments for some of the other energy levels have been attempted. The spins of these states cannot be uniquely determined on the basis of the Butler analysis, but the possible spin limits are listed. A $Be^9(d, p)Be^{10}$ exposure was also made. There do not appear to be any states in Be^{10} between the ground state and the known 3·37-MeV level. A.

539.172.13

440. The angular distribution of alpha-particles from the reaction of deuterons with tritons. T. F. Stratton and G. D. Freier. *Phys. Rev.*, **88**, 261–3 (*Oct.* 15, 1952).

The distribution, as a function of angle, of the α-particles produced in the reaction of deuterons on tritons has been measured using a monoergic beam of deuterons from the Minnesota electrostatic generator. The α-particles were detected in the angular range of 40° to 140° in the centre-of-mass system of coordinates for an incident deuteron energy of 2·21 MeV in the laboratory. The centre-of-mass differential reaction cross-section was flat at 8 millibarns from 40° to 90° and rose to about 13 millibarns at 140°. A.

539.172.13

441. The Born approximation theory of (d, p) and (d, n) reactions. P. B. Daitch and J. B. French. Letter in *Phys. Rev.*, **87**, 900–1 (*Sept.* 1, 1952).

It is demonstrated that Butler's stripping theory [Abstr. 8973 (1951)] is essentially equivalent to a Born approximation calculation. W. J. Swiatecki

539.172.13

442. Stripping and pick-up differential cross sections. S. T. Butler and E. E. Salpeter. Letter in *Phys. Rev.*, **88**, 133–4 (*Oct.* 1, 1952).

Summary of the results of an extension of previous work on (d, p) and (p, d) reactions [Abstr. 8973 (1951)] to cover (t, d) and (d, t) reactions. A. O. Stanesby

539.172.3

443. On the high energy nuclear photoelectric reaction. S. Yoshida, Letter in *Progr. theor. Phys.*, **6**, 1032–4 (*Nov.–Dec.*, 1951).

The proton is assumed to be produced in a subunit of the nucleus. To reproduce the observed angular distribution the size of the subunits must vary with energy. W. J. Swiatecki

539.172.3

444. Resonance effects in the photo-disintegration of ^{16}O nuclei into four α-particles. D. L. Livesey and C. L. Smith. Letter in *Proc. Phys. Soc.* [*London*] *A*, **65**, 758–9 (*Sept.*, 1952).

Measurements of 83 nuclear emulsion stars suggest

yield resonances near 22 MeV, 25 MeV and possibly 29 MeV γ-ray energy. J. J. WILKINS

539.172.3

445. Threshold for γ-p in Be^9. B. L. TUCKER AND E. C. GREGG. Letter in *Phys. Rev.*, **87**, 907 (*Sept.* 1, 1952).

The 0·88 sec β-activity from $Be^9 + \gamma \rightarrow p + Li^8$; $Li^8 \rightarrow \beta + Be^8$ was detected by an NaI crystal and 5819 photo-multiplier and leads to a threshold of 16·93 ± 0·15 MeV and a cross-section of $\sim 3 \times 10^{-28}$ cm² at 19 MeV. W. J. SWIATECKI

539.172.3

446. Cross-section for the reaction $Br^{81}(\gamma, \alpha)As^{77}$. J. G. V. TAYLOR AND R. N. H. HASLAM. Letter in *Phys. Rev.*, **87**, 1138–9 (*Sept.* 15, 1952).

Counting the product As^{77} indicated a peak cross-section of 0·27 millibarns at 21·5 MeV and an integrated cross-section of 1·5 MeV-millibarns. J. J. WILKINS

539.172.3

447. The angular distribution of fission fragments in the photofission of thorium. E. J. WINHOLD, P. T. DEMOS AND I. HALPERN. Letter in *Phys. Rev.*, **87**, 1139–40 (*Sept.* 15, 1952).

This was measured by collecting and counting the β-activities of the fragments, using incident X-ray peak energies of 8 to 16 MeV. At 16 MeV the result was $1 + (0{\cdot}41 \pm 0{\cdot}09) \sin^2\theta$, the asymmetry increasing rapidly with decreasing peak energy. J. J. WILKINS

539.172.3

448. Production of photomesons in deuterium. J. KECK AND R. LITTAUER. Letter in *Phys. Rev.*, **88**, 139 (*Oct.* 1, 1952).

Using 310 MeV bremsstrahlung, the angular and energy distributions of proton recoils were observed in coincidence with 56 MeV (π^-) mesons at 90°. The angular distribution (but not the energy distribution) was consistent with a process involving only the neutron of the deuteron. J. J. WILKINS

539.172.3

449. Photomesons from the deuteron. J. A. THIE. Letter in *Phys. Rev.*, **88**, 420 (*Oct.* 15, 1952).

The theory of Chew and Lewis (1951) is applied to the calculation of the coincidence cross section between a meson or its decay product and a recoiling nucleon of the disintegrated D. There is a discrepancy with experiments of Keck and Littauer (preceding abstract). W. J. SWIATECKI

539.172.3

450. The reaction $Li^6(\gamma, d)He^4$ at 2·76 MeV. H. B. GLENN. Letter in *Phys. Rev.*, **88**, 415 (*Oct.* 15, 1952).

Using γ's from Na^{24} and emulsions loaded with enriched Li^6, 2 possible events were found giving $(4 \pm 4) \times 10^{-30}$ cm² as an upper limit for the cross-section. W. J. SWIATECKI

539.172.3 : 539.18

451. On the Z-dependence of the positive-negative ratio of the mesons produced by photons on nuclei. S. MACHIDA AND T. TAMURA. Letter in *Progr. theor. Phys.*, **6**, 1030–2 (*Nov.–Dec.*, 1951).

By assuming the interaction to take place with a single α-particle cluster or with nucleons unpaired in such clusters, and taking into account the binding energy difference for the final nuclei the experimental Z-dependence can be reproduced. W. J. SWIATECKI

539.172.4

452. On (n, d) reactions produced by slow neutrons on separated zinc isotopes, as well as on nickel. H. FARAGGI, R. BERNAS AND A. BONNET. *C.R. Acad. Sci. [Paris]* **235**, 425–7 (*Aug.* 11, 1952) *In French.*

Emulsions in contact with Zn plated on Ni were exposed to $7{\cdot}5 \times 10^{11}$ neutrons/cm². From 5 α-tracks of range 38 μ it is deduced that the cross-section for $Zn^{67}(n, d = 7{\cdot}5$ MeV)Ni^{64} is $5{\cdot}5 \times 10^{-30}$ cm². For $Zn^{66,68}$ $\sigma < 2 \times 10^{-29}$ cm² and for Ni $\sigma < 2 \times 10^{-30}$ cm². See also Abstr. 6055 (1952). W. J. SWIATECKI

539.172.4

453. Neutron total cross section for lead between 37 and 156 MeV. A. E. TAYLOR AND E. WOOD. Letter in *Phys. Rev.*, **87**, 907–8 (*Sept.* 1, 1952).

A dip was found at about 60 MeV, and similar dips at lower energies in Cd and Cu. F. R. HOLT

539.172.4

454. Total cross sections of carbon and hydrogen for high energy neutrons. G. R. MOTT, G. L. GUERNSEY AND B. K. NELSON. *Phys. Rev.*, **88**, 9–14 (*Oct.* 1, 1952).

Measurements of the total cross-sections of carbon and hydrogen have been made at neutron energies of 97 ± 5, 117 ± 5, 140 ± 5, 156 ± 5, 180 ± 7 and 220 ± 10 MeV, using a calibrated anthracene crystal as an energy sensitive detector for recoil protons. This proportional crystal was used as the fourth of a quadruple coincidence anthracene scintillation counter telescope which detected recoil protons scattered at 20° from a polyethylene radiator in the collimated neutron beam from the University of Rochester 130-in synchrocyclotron. The methods employed permit the simultaneous measurement of total cross-sections over a continuous spectrum of neutron energies. The results are in general agreement with previously reported data. A.

539.172.4

455. Differential n–p scattering cross section for 220-MeV neutrons. G. GUERNSEY, G. MOTT AND B. K. NELSON. *Phys. Rev.*, **88**, 15–19 (*Oct.* 1, 1952).

This has been investigated as a function of angle for neutron energies of 220 MeV and 180 MeV. A ½-in. Be target at the 58¼-in. radius in the University of Rochester 130-in. cyclotron was used to produce a beam of neutrons. This neutron beam scattered protons from a polyethylene scatterer which were detected by a four scintillation counter coincidence telescope. A measurement of the pulse height from the last counter was used to determine the energy of the scattered proton. The effect of the carbon in the polyethylene was subtracted by taking runs with a carbon scatterer calculated to have the same number of carbon atoms per cm² as had the polyethylene. Runs were taken from 0° to 50° for the proton angle in the laboratory coordinate system. A comparison is made of the 220-MeV angular distribution with the Berkeley 260-MeV data which indicates essential agreement of the shapes. A.

539.172.4

456. Total cross sections of heavy nuclei for fast neutrons. D. W. Miller, R. K. Adair, C. K. Bockelman and S. E. Darden. *Phys. Rev.*, **88**, 83–90 (*Oct.* 1, 1952).

The total neutron cross-sections of 23 heavy elements from Fe to Bi have been determined as a function of neutron energy from about 0·05 MeV to 3·2 MeV. Every element whose major isotope (>50% abundant) has a closed neutron shell of 50, 82 or 126 neutrons is included among the elements investigated. Below 1·4 MeV, neutrons having an energy spread of 20 keV were employed to take measurements at 20-keV intervals on Sr, Yt, Ba, La, Ce and Pr. Nb and Mo were also investigated in this region using energy intervals of 70 keV between measurements. These measurements and earlier low energy measurements on fifteen other heavy elements were extended to 3·2 MeV, using an energy spread of 20 keV and intervals between points of about 200 keV. The most unusual feature of the results is a very broad maximum which is clearly observed in the total cross-sections of thirteen of the elements studied. This maximum appears to move to higher neutron energies with increasing mass number. The position and shape of the maximum seems to be independent of all other nuclear details, such as the nuclear spin or the binding energy of the added neutron. When averaged over resonances, the total cross-sections of the closed-shell nuclei do not appear to be different from the total cross-sections of other nuclei of about the same masses. There is some indication that the spacing of resonances in the total cross-sections of the closed-shell nuclei is greater than observed in the cross-sections of other nuclei. A.

539.172.4

457. Neutron capture cross-sections. B. Margolis. *Phys. Rev.*, **88**, 327–31 (*Oct.* 15, 1952).

Cross-section formulae for neutron capture are developed by means of statistical theory, for intermediate and heavy weight nuclei for energies of the order of 1 keV to a few MeV. The formulae do not exhibit resonances, but are rather averages over resonances in the energy region where these exist. The case is treated where the residual nucleus levels are well separated, although the method is applicable in principle where these levels form a virtual continuum. The processes competing with capture in the energy range considered are elastic and inelastic scattering. The energy dependence of radiation widths is estimated. The ratio of energy level spacing to radiation width at the dissociation energy of a neutron enters as a parameter in the cross-section formulae. This ratio is chosen to make experiment and theory agree as well as possible. Taking the spacing of levels of a given spin and parity at the dissociation energy of a neutron to be 25 eV, the values of the radiation widths are found to be 0·08 eV for Ag^{108} and In^{116}, 0·10 eV for Ag^{110}, and 0·20 eV for Au^{198}. A.

539.172.4

458. Thermal neutron capture cross sections. H. Pomerance. *Phys. Rev.*, **88**, 412–13 (*Oct.* 15, 1952).

The thermal neutron capture cross-sections of more than one hundred isotopes, including all the isotopes of 24 elements, plus several others, have been measured with the Oak Ridge National Laboratory pile oscillator. A.

539.172.4

459. Current status of nuclear reactor theory. A. M. Weinberg. *Amer. J. Phys.*, **20**, 401–12 (*Oct.*, 1952).

The mathematical theory of neutron chain reacting systems bears considerable similarity to the mathematical theory of quantum mechanisms since the Schroedinger equation can be viewed as the equation for an infinitely large chain reactor in which the potential function is replaced by the distribution of neutron absorption cross-sections. The chain reactor theory, not being self-adjoint, is somewhat more complicated than the Schroedinger equation theory. Nevertheless, perturbation theory, time dependent theory, and the theory of the stationary, i.e. just critical, state can be stated in much the same way as is done in quantum mechanics. A.

539.172.4

460. Transfer function of Argonne CP-2 reactor. J. M. Harrer, R. E. Boyar and D. Krucoff. *Nucleonics*, **10**, 32–6 (*Aug.*, 1952).

A sinusoidal variation in the reactivity of the CP-2 reactor, was applied by means of a cadmium rod oscillating into and out of a cadmium sleeve situated near the centre of the pile. The magnitude of the resulting power level oscillation and the shift in phase of these oscillations with respect to the mechanical motion were measured with the help of a BF_3 chamber. An expression relating these effects to the magnitude of the δk variation and the known delayed neutron periods (the so-called transfer function) is derived theoretically and is found to be in good agreement with the experimental results. L. R. SHEPHERD

539.172.4

461. Spallation of Cu with high energy neutrons. L. Marquez. *Phys. Rev.*, **88**, 225–7 (*Oct.* 15, 1952).

The yields of spallation products of Cu with high energy neutrons have been measured and are given. The results are similar to those obtained with high energy protons. This similarity and some apparent differences are pointed out. A.

ATOM AND MOLECULE BEAMS . MESONS NEUTRONS 539.18

539.18

462. On a possible model of the *V*-particle. K. Aizu and T. Kinoshita. Letter in *Progr. theor. Phys.*, **6**, 630–1 (*July–Aug.*, 1951).

Assumes the V to be an elementary fermion, produced as V–N pairs. The observed production and decay rates can be explained. E. P. GEORGE

539.18

463. A model for *V*-particles. H. Miyazawa. Letter in *Progr. theor. Phys.*, **6**, 631–3 (*July–Aug.*, 1951).

The V_2^0 is assumed to be a fundamental fermion, decaying into $\pi + \mu$, the V_1^0 to be a V_2^0 in a bound state of a nucleon. The following decay schemes result: $V_1^0 \rightarrow P + \mu$, $V_2^0 \rightarrow \pi + \mu$. E. P. GEORGE

539.18

464. Note on the theory of *V*-particles and τ-mesons. S. Ôneda. Letter in *Progr. theor. Phys.*, **6**, 633–5 (*July–Aug.*, 1951).

Assumes τ-mesons are bosons and strongly coupled to nucleons. The coupling constants can then be adjusted to fit the observed production and decay rates. E. P. GEORGE

539.18

465. *V*-particle as a composite one. H. Suura. Letter in *Progr. theor. Phys.*, **6**, 893–5 (*Sept.–Oct.*, 1951).

The possibility that the V_1^0 may be a composite particle composed of a proton and a τ^- is examined. E. P. GEORGE

539.18

466. π^0-Meson production by gamma-ray. S. Minami. Letter in *Progr. theor. Phys.*, **6**, 895–6 (*Sept.–Oct.*, 1951).

The terms of order ef and ef^3 of the *S*-matrix element for the process $\gamma + P \rightarrow P + \pi^0$ are given. Owing to cancellation, the term ef is small so that, in the cross-section obtained, the terms e^2f^6 are dominant (the cross-terms $(ef)\times(ef^5)$ have not been calculated). Numerical results are given for $f^2/4\pi = 8\pi$, both for this process and the process $\gamma + N \rightarrow N + \pi^0$. R. H. DALITZ

539.18

467. *V*-particles and nuclear phenomena. S. Ôneda. Letter in *Progr. theor. Phys.*, **6**, 1014–17 (*Nov.–Dec.*, 1951).

In this theory, *V*- and τ-particles are produced as *V*–*V* or *V*–τ pairs. The contributions to the nucleon magnetic moments are discussed. E. P. GEORGE

539.18

468. On the short μ-meson tracks from π-meson decays. T. Nakano, J. Nishimura and Y. Yamaguchi. Letter in *Progr. theor. Phys.*, **6**, 1028–30 (*Nov.–Dec.*, 1951).

The observation by Fry (1951) of 2 π–μ events with very short μ range (200 microns) could be explained by the "radiative correction" $\pi^\pm \rightarrow \mu^\pm + \nu^0 + \gamma$ to normal π–μ decay. Its probability is estimated. W. J. SWIATECKI

539.18

469. The burst production by the μ-meson. H. Komori, K. Miyanaga and S. Ogawa. Letter in *Progr. theor. Phys.*, **7**, 122–3 (*Jan.*, 1952).

The contribution of π^0 production by μ-mesons is examined and found to be small, and not to modify the generally accepted assignment of 0 or ½ to the spin of the μ-meson. E. P. GEORGE

539.18

470. Neutrons produced in the absorption of negative π-mesons at rest. V. Cocconi Tongiorgi and D. A. Edwards. Letter in *Phys. Rev.*, **88**, 145 (*Oct.* 1, 1951).

Mesons of 30–75 MeV passed through 3 trays of G.M. counters, were brought to rest in Pb, Sn, Al or C, and emitted neutrons of 0·5–15 MeV, detected by 20 BF_3 counters in $3\times3\times2{\cdot}5$ ft³ of paraffin. The results support the interpretation that the 30% of starless meson tracks in emulsions are associated with *n* emission. W. J. SWIATECKI

539.18

471. The lifetimes of the π^+ and π^- mesons. R. P. Durbin, H. H. Loar and W. W. Havens, Jr. *Phys. Rev.*, **88**, 179–83 (*Oct.* 15, 1952).

The mean lives of the π^+ and π^- mesons are determined by measurements of the attenuation in flight of a 73-MeV meson beam, using a scintillation counter telescope of variable length. The decay scheme, $\pi^\pm \rightarrow \mu^\pm + \nu$, is assumed to be isotropic in the rest system of the π meson. The data, when the Lorentz time dilation is taken into account, give for the mean lives at rest $\tau_- = (2{\cdot}55 \pm 0{\cdot}19)\times10^{-8}$ sec, $\tau_+ = (2{\cdot}44 \pm 0{\cdot}18)\times10^{-8}$ sec. A.

539.18

472. The energy spectrum of positrons from the decay of the μ-meson. H. J. Bramson, A. M. Seifert and W. W. Havens, Jr. *Phys. Rev.*, **88**, 304–8 (*Oct.* 15, 1952).

The energy of the positrons from $301\ \pi \rightarrow \mu \rightarrow \beta$ decays have been determined in electron sensitive emulsions by measuring the multiple scattering of the positron tracks. The annihilation properties of the charged particle emitted in the decay of the μ^+ meson confirm its identity as a positron. This spectrum has a maximum about 36 MeV and a non-zero cutoff at the high energy end. A statistical analysis of the data, using the Michel theory, yields a value of $\rho = 0{\cdot}41 \pm 0{\cdot}13$. A.

539.18 : 537.591

473. A note on the Fermi's theory of meson production. Y. Fujimoto and T. Tamura. Letter in *Progr. theor. Phys.*, **6**, 901–2 (*Sept.–Oct.*, 1951).

Data on meson production by protons of 1–8 BeV and > 8 BeV in light and heavy nuclei suggests a multiplicity of production greater than that of Fermi's theory and it is considered that secondary meson production by the mesons produced in nucleon-nucleon collisions can account for the discrepancies. R. H. DALITZ

539.185

474. Multiple magnetic scattering. E. Alfsen. *C.R. Acad. Sci.* [*Paris*] **235**, 535–7 (*Sept.* 8, 1952) *In French.*

Using the multiple scattering equations, the refractive index is calculated for a neutron beam in a ferromagnetic medium described by a mean induction $\bar{B}$. Besides the nuclear term, this contains a magnetic term leading to double refraction phenomena. R. H. DALITZ

539.185

475. Multiple scattering of neutrons. III. Scattering by spin-dependent forces and polarization phenomena. O. Halpern. *Phys. Rev.*, **88**, 232–5 (*Oct.* 15, 1952).

For Pt II, see Abstr. 2697 (1950). The treatment of Pts I and II is extended to cover the case of spin-dependent forces. A general theorem is derived which reduces the problem of scattering by spin-dependent forces to the problem of scattering by spin-independent forces, which has previously been solved analytically. It is shown that observations on the neutrons returning from the scatterer can be used in many practical cases to determine the ratio of the two scattering amplitudes. Similarly, for very small probability of depolarizations per single collision, the

depolarization of the neutrons transmitted through the scatterer offers information about the spin dependence of the scattering amplitudes. The necessary material for the evaluation of the observation is presented in table form. A comparison is made with a paper by Borowitz and Hamermesh in which the same subject has been treated by a different method. A.

539.185

476. The complete solution of the one-velocity diffusion problem at intermediate and large distances. L. TONKS. *J. appl. Phys.*, **23**, 1085–8 (*Oct.*, 1952).

An approximate evaluation of the branch-cut integral which occurs in the rigorous solution of the Boltzmann equation for intermediate and large distances is of importance in shielding problems. Such an evaluation leads to equations for the point source and the plane source. The former is actually 23% high for zero absorption ($f = 0$) and $r\sigma = 7$, but the error decreases with increasing $r\sigma$ and f. It is seen that the branch-cut term is not simply the contribution of non-collided neutrons. A.

539.185

477. The variational method for problems of neutron diffusion and of radiative transfer. S.-S. HUANG. *Phys. Rev.*, **88**, 50–2 (*Oct.* 1, 1952).

The functional as proposed by R. E. Marshak [Abstr. 2254 (1947)] for solving certain inhomogeneous integral equations by the variational method is modified in such a way that the simultaneous equations which determine the parameters become linear. Thus this type of integral equations can be solved with an accuracy as high as required without much labour. As an illustration an approximate solution of Milne's integral equation for the neutron density (or for the source function in the problem of radiative transfer) is obtained in a simple form. This approximate solution agrees (for the first four figures) everywhere with the one computed by C. Mark (1947) from the exact solution. A.

539.185.08

478. A fast neutron scintillation spectrometer R. F. MOZLEY AND F. C. SHOEMAKER. Letter in *Rev. sci. Instrum.*, **23**, 569 (*Oct.*, 1952).

Neutrons in the energy range 2 — 18 MeV are studied by using scintillations due to proton recoils in an anthracene crystal, a second crystal and multiplier being used to define the angle of proton recoil. The pulses from each multiplier are added to give the neutron energy. Background counts due to γ-rays are eliminated by using a proportional counter between the crystals which gives a dE/dx measurement to identify the proton recoils. Only triple coincidences are recorded. For the given apparatus the counting efficiency is 2×10^{-4} at 20 MeV and 2×10^{-5} at 2 MeV. G. F. J. GARLICK

STRUCTURES OF SOLIDS 539.2

539.215 : 541.18.043

479. Production and separation of small glass spheres. W. PAUL AND R. V. JONES. *Brit. J. appl. Phys.*, **3**, 311–14 (*Oct.*, 1952).

Glass spheres free from gaseous inclusions have been made in the size range 1–40 μ. They have been separated with relatively high accuracy into narrow ranges of size by a new sedimentation method using a liquid column containing a gradient of density. A.

539.217

480. The Kirkendall effect in alloy systems. H. N. HERSH. Letter in *J. appl. Phys.*, **23**, 1055–6 (*Sept.*, 1952).

The dezincification of 70/30 α-brass specimens (8–16 mm) by annealing *in vacuo* at 700°C, is accompanied by their shrinkage at a rate proportional to the square root of the annealing time, and by a marked porosity of the samples near their surfaces. The porosity indicates that the shrinkage is not adequate fully to compensate for the loss of zinc. These results are discussed in connection with phenomena in ordinary diffusion experiments. A. D. LE CLAIRE

539.217

481. Theoretical analysis of the diffusion processes determining the oxidation rate of alloys. C. WAGNER. *J. Electrochem. Soc.*, **99**, 369–80 (*Oct.*, 1952).

The interplay of diffusion processes in metallic and oxide phases during the oxidation of alloys is analysed theoretically for specified ideal conditions. The oxidation rate of alloys containing a noble metal (Au or Pt) and an oxidizable metal (Ni, Cu or Zn) is calculated as a function of the alloy composition. The oxidation rate of Ni–Pt alloys at 850° and 1100°C is essentially determined by the diffusion of nickel to the alloy–NiO interface if the mole fraction of nickel is less than 0·5. Observed oxidation rates are in accordance with values calculated from diffusion data. Alloys in which both constituents are oxidizable may form either a one-phase or a two-phase scale. A necessary but not sufficient condition for the formation of a scale consisting of only one oxide is stated. Results for Cu–Ni and Cu–Zn alloys are essentially in accordance with theoretical considerations. On the other hand, it is shown that two oxides may nucleate initially and continue to grow even under conditions under which exclusive formation of the oxide of the less noble metal is a possible process. This is illustrated by observations on Cu–Al alloys. A.

539.217 : 669

482. Metallurgical equilibrium diagrams. W. HUME-ROTHERY, J. W. CHRISTIAN AND W. B. PEARSON. *London, Institute of Physics* (1952) 312 *pp.*

Includes a theoretical introduction; details of general laboratory technique; the different methods of pyrometry; full description of experimental methods for the determination of the liquidus including special chapters on high melting alloys; determination of the solidus, and solid solubility curves; the use of X-ray methods; ternary systems from both the theoretical and experimental viewpoint. A.

539.219.1

483. Nitrogen in metals. D. O. CALDWELL. Letter in *Rev. sci. Instrum.*, **23**, 501–2 (*Sept.*, 1952).

The possibility of finding nitrogen impurity throughout samples of metals (not just on their surface) is pointed out. After proton bombardment strong O^{14} and C^{11} activities were found in Mn, Fe, Cb, Rh and Ta, but none in Al, V, Cr and Ni.

J. J. WILKINS

539.219.2 : 548.7

Effect of internal strains on linear expansions, X-ray lattice constant, and density of crystals. *See Abstr.* 535

539.234

484. The contamination in evaporated films by the material of the source. O. S. HEAVENS. *Proc. Phys. Soc.* [*London*] *B*, **65**, 788–93 (*Oct.*, 1952).

Two methods have been used to detect contamination in evaporated films of Ag and Ge by the boats or filaments used as sources. It is shown that a limit of a few parts in ten thousand of W or Mb is attainable by microchemical methods. The much lower limit of one or two parts in 10^7 is attained by the radioactive tracer method. The extent of contamination of films of Ag and Ge by W and Ta boats has been studied using the tracer technique and the minimum contamination attainable found to be of the order of a few parts per million. The possibilities of transfer of the boat material by direct evaporation or by reaction with the residual gas in the system have been minimized; the results suggest that contamination arises by the solution of the boat materials by the molten Ag or Ge. A.

539.24 : 535.45

Structure of evaporated metal films. *See Abstr.* 142–3

539.24 : 537.311.1

Mean free paths of electrons in evaporated metal films. *See Abstr.* 214

539.26 : 539.374

485. A new effect of cold work on powder X-ray patterns. S. ANNAKA. Letter in *J. chem. Phys.*, **20**, 1662–3 (*Oct.*, 1952).

No superlattice lines are obtained from either CuAu or Cu_3Au if the originally ordered samples have been cold worked by filing. Also the tetragonal pattern of lines from ordered CuAu is replaced after filing by a f.c.c. pattern. A. D. LE CLAIRE

539.26 : 539.4.016.2

486. The separation of stacking fault broadening in cold worked metals. B. E. WARREN AND B. L. AVERBACH. Letter in *J. appl. Phys.*, **23**, 1059 (*Sept.*, 1952).

Stacking faults in general produce a broadening of X-ray reflections, but not of the (333) or (600) reflections from f.c.c. crystals. A comparison of the shape of these latter lines with others, employing an analysis which permits the separation of any broadening due to particle size or to lattice distortion, shows that there is no measurable broadening due to stacking faults in the cold worked single crystal of 2% SiCu which was examined. A. D. LE CLAIRE

539.26 : 669

487. X-ray studies of metal structures. W. H. TAYLOR. *Rep. Brit. Elect. Res. Assoc.*, *Ref. L/T226*, 12 *pp.* (1952).

ELASTICITY . STRENGTH . RHEOLOGY

539.3/.8

539.32

488. Measurement and importance of elastic properties of metals. *Nature* [*London*] **170**, 527–9 (*Sept.* 27, 1952).

Report of a conference at the National Physical Laboratory during March 20–21 (1952). Summaries are given of the 10 papers which were presented and discussed, dealing with various techniques of measurement, with some experimental results, particularly on Cu and Al alloys, and with the theoretical interpretation of elastic constants and their importance in solid state physics and in engineering. A. D. LE CLAIRE

539.32 : 536.21 : 535.345 : 532.739.2

489. A comparison of the physical properties of barium fluoride and calcium fluoride. S. S. BALLARD, L. S. COMBES AND K. A. MCCARTHY. Letter in *J. Opt. Soc. Amer.*, **42**, 684–5 (*Sept.*, 1952).

Gives Young's modulus, elastic limit, hardness, thermal conductivity, limits of transmittance, melting point and solubility. C. TURNER

539.374

490. Surface effects in plastic deformation of metals. A. F. BROWN. *Advances in Phys.*, **1**, 427–79 (*Oct.*, 1952).

A critical survey of their plastic properties as revealed by studies of the surfaces of deformed metals. The appearance of slip bands shows that deformation is not homogeneous but is concentrated on relatively few atomic planes, although recent evidence suggests that this conclusion is valid only in the later stages of deformation; the first fractional percent of strain is much more nearly homogeneous. Theories to account for both these stages of deformation are examined in the light of microscopical evidence. The validity of conclusions about internal processes based on surface examination is discussed; it is shown that the surface finish affects not only the appearances of internal processes but also the processes themselves. When the deformation is inhomogeneous the balance of evidence is that it is also not continuous in time: instead, slip on an active slip plane tends to a limit which is reached either gradually or suddenly depending on the nature of the metal and the conditions of stress. The same processes which stop slip on the active planes produce general hardening of the metal. However, slip can restart on or near to former slip planes as a result of mechanisms activated by temperature and stress, and can in favourable cases continue until fracture. Therefore slip bands, the sources of hardening, are also places of weakness. 100 references, 60 photographs and 17 figures. A. D. LE CLAIRE

539.374 : 535.345

491. An optical investigation of the plastic deformation of silver chloride. E. ROHLOFF. *Z. Phys.*, **132**, *No.* 5, 643–54 (1952) *In German.*

The light absorption in AgCl crystals containing spherical colloidal particles of Ag of various diameters is calculated by Mie's theory. The corresponding calculations are made for ellipsoidal particles, such as would be found in the same crystals after rolling, and the dichroism for polarized light absorbed by the rolled crystals is deduced. The processes of internal rearrangement involved in plastic deformation of AgCl and subsequent recovery are followed by means of optical observations interpreted on the basis of this theory. J. G. OLDROYD

539.42 : 539.133

492. Effect of orientation on the ultimate strength of linear high polymers. C. C. HSIAO. Letter in *J. appl. Phys.*, **23**, 1189–90 (*Oct.*, 1952).

A theory has been developed which permits the

evaluation of strength as a function of orientation in terms of strain change; the theoretical calculations agree with experimental results of the effect of uniaxial orientation under tension on ultimate strength. The theory also applies for cases of biaxial and triaxial orientation. F. LACHMAN

539.434

493. Strain-hardening and softening with time in reference to creep and relaxation in metals. A. NADAI. *Trans Amer. Soc. Mech. Engrs*, **74**, 403–13 (*April*, 1952).

Analytical expressions are formulated for describing the influence of strain-hardening, of the time rate of change of the flow resistance, and of recovery strains on the creep and relaxation of metals under uniaxial stress. A.

539.501

494. Rheological properties of a high asphaltene content bitumen. N. KLEIN. Letter in *Bull. Res. Coun. Israel*, **2**, 66–7 (*June*, 1952).

The total elastic recovery was measured in a conicylindrical viscometer for different displacement and loads. The recovery strain/displacement curve shows peaks at small displacements. An interpretation in terms of entangled coils of hydrocarbon chains is suggested. J. E. CAFFYN

539.501 : 517.942.922

495. A property of Bessel functions and its application to the theory of two rheometers. H. MARKOVITZ. *J. appl. Phys.*, **23**, 1070–7 (*Oct.*, 1952).

A method of expanding expressions of the type $J(\xi)Y(\sigma) - J(\sigma)Y(\xi)$ and $J'(\xi)Y(\sigma) - J'(\sigma)Y(\xi)$ is given. Here J and Y are Bessel functions of the first and second kind. These forms occur frequently in physical problems with cylindrical symmetry. The type of expansion used here can be used with other functions that are solutions of second-order differential equations. The use of these expansions allows the development of theories for two rheometers used for determining dynamic mechanical properties of liquids. In these mathematical treatments, the inertia of the sample is taken into account. A.

539.61 : 539.23

496. Bonding of thin films. H. P. MEISSNER AND J. BYRNE. *J. appl. Phys.*, **23**, 1170–3 (*Oct.*, 1952).

Unsupported films of nitrocellulose of 0·25 micron and less in thickness bonded immediately and spontaneously in air to solid surfaces which they were made to touch. Bond strength increased with diminishing film thickness. Similar behaviour was shown by films of gold, regenerated cellulose, polymethyl methacrylate and gelatin. This bonding power of nitrocellulose films, which was apparently not attributable to static electricity or to mechanical joint formation, was lost while immersed in water, benzene or hexane, but was regained upon removal and drying. A.

PHYSICAL CHEMISTRY 541

PHASE EQUILIBRIUM . CHEMICAL REACTIONS 541.11/.12

541.115 : 548.0

497. Some crystal energetic relationships in oxysalts. H. RAMBERG. *J. chem. Phys.*, **20**, 1532–7 (*Oct.*, 1952).

A regularity exists between the heat of formation of alkali and alkaline earth oxysalts and the acidity and basicity of the oxides involved. The more basic an alkali or an alkaline earth oxide, the larger is the exothermic heat of formation of its oxysalts from the component oxides. Likewise, the more acidic the non-metal oxide, the larger is the exothermic heat of formation of its salts from the component oxides. Although this is expectable in a general way, the regularity and consistency of these rules are rather surprising. The exothermic heat of formation from the oxides of different oxysalts of the same metal increases when the non-metal changes through the sequences: B, C, N and Si, P, S, Cl. This is explained in light of the increasing covalent character (or increasing polarization) of the oxygen–non-metal bonds through the same series of elements. The exothermic heat of formation of polymerized oxysalts from the component oxides (borates, silicates, phosphates, pyrosulphates) is larger per equivalent than for the corresponding simple oxysalts. This is qualitatively explained as a result of the oxygen–non-metal bond being less polarized or more ionic in a polymerized salt than in the non-polymerized salt with the same central atom in the oxyanion. The heat of salt formation per equivalent increases numerically when the metal changes from Li to Cs, or from Mg to Ra. This is related to the increase of the crystal energy of the corresponding metal oxides. A.

541.123.59 : 539.155.2

498. Separation of high specific activity sodium^{22} from large quantities of magnesium. V. J. LINNENBOM. Letter in *J. chem. Phys.*, **20**, 1657–8 (*Oct.*, 1952).

Details of an ion-exchange method of separating Na^{22} from large amounts (15 g) of Mg are given. Specially treated Dowex-50 resin is used as the exchanger. A. J. MEE

541.124

499. The induction period in chain reactions. S. W. BENSON. *J. chem. Phys.*, **20**, 1605–12 (*Oct.*, 1952).

The conditions for the establishment of a stationary state in a system of consecutive reactions can be investigated quantitatively in a sufficient number of cases to permit precise criteria to be formulated generally for the length of the induction period (i.e. prestationary state period) in chain reactions. These are given as functions of the individual rate constants for the separate reactions, the extent of the reaction and the percent of stationary state concentrations achieved. Such relations provide a means for the evaluation of the self-consistency of experimental data with proposed mechanisms and also provide numerical limits on the values of individual rate constants. Various chain reactions are examined in the light of these criteria. Of the hydrogen–halogen reactions, the H_2–Cl_2 reaction mechanism does not fulfil the

stationary state requirements and it is probable that many of the discordant results found in this reaction arise from this difficulty. A.

541.124 : 533.77

500. The thermal dimerization of butadiene, and the equilibrium between butadiene and vinylcyclohexene. N. E. DUNCAN AND G. J. JANZ. *J. chem. Phys.*, **20**, 1644–5 (*Oct.*, 1952).

The kinetics of the dimerization of butadiene and of the dissociation of vinylcyclohexene have been considered in the light of thermodynamic equilibrium calculations. The lack of accord between the results is resolved if the dissociation of vinylcyclohexene is given by the rate expression:

$$k_d = 5{\cdot}02 \times 10^{15} \exp(-61\,800/RT)\ \text{sec}^{-1}.$$ A.

541.126

501. Effect of withdrawal-rate on second explosion limits. A. C. EGERTON AND D. R. WARREN. Letter in *Nature* [*London*] **170**, 420–1 (*Sept.* 6, 1952).

Baldwin and Precious [Abstr. 4689 (1952)] attributed this effect, in the case of the H_2–O_2 reaction, to the participation of quadratic branching in the reaction. Evidence is here presented in support of an alternative explanation: the reduction of the net branching factor to zero by the products formed during the initial stages of the explosion. A. SCHOFIELD

541.126

502. Slow combustion of cyclopropane. A. C. MCEWAN AND C. F. H. TIPPER. Letter in *Nature* [*London*] **170**, 462 (*Sept.* 13, 1952).

Slow thermal oxidation of cyclopropane has been investigated between 380°C and 430°C at partial pressures of the reactants between 50 and 400 mm Hg. It was found that at any temp., when the partial press. of O_2 is less than a certain critical value $p_c(O_2)$, the maximum reaction rate $R(\max) \propto p(C_3H_6) \cdot p(O_2)$; when $p(O_2) > p_c(O_2)$, $R(\max) \propto p^2(C_3H_6)$. The value of $p_c(O_2)$ increases greatly as the temp. or the partial pressure of cyclopropane ($p(C_3H_6)$) is increased. The overall activation energy of the reaction (approx. 35 kcal/mole) is the same above and below $p_c(O_2)$. It is suggested that these results cast doubt on the view that slow oxidations of hydrocarbons in the low- and high-temp. regions are kinetically distinct, and that a reaction-rate independent of O_2-concentration would be obtained at any temperature if $p(O_2)$ were high enough. A. SCHOFIELD

541.127

503. Detonation of liquid and solid explosives. E. SAENGER. *C.R. Acad. Sci.* [*Paris*] **235**, 461–3 (*Aug.* 18, 1952) *In French.*

It is pointed out that if the energy of compression of the initial shock activates solely the translational degrees of freedom of the molecular products of explosion, the thermal radiation from these products is sufficient to vaporize the solid or liquid explosive slightly ahead of the shock. On this basis it is suggested that the first stage of detonation of a solid or liquid explosive consists in the formation of a thin layer of vaporized explosive at low pressure, in which the shock wave initiating the chemical reaction is propagated. A. SCHOFIELD

541.127

504. An experimental investigation of spinning detonation. R. E. DUFF AND H. T. KNIGHT. Letter in *J. chem. Phys.*, **20**, 1493–5 (*Sept.*, 1952).

Observations of the pitch-diameter ratio of spinning detonation waves in CO–O_2 mixtures containing 30–90% CO show good agreement with theoretical predictions from the acoustic theories of Manson [Abstr. 555 (1947)] and Fay (to be published). Spin cannot be set up in a wide glass tube, but is observed in a wide Lucite tube; the latter, which is not shattered by the detonation wave, provides confinement for the wake, which according to the acoustic theory is essential for the maintenance of spin. Further support for the acoustic theory is provided by the observation of a luminous region in streak photographs of the wake, which is predicted by this theory. From the distortion of a 0·0002 in thick Dural foil transverse to the tube axis, it is concluded that the surface of the spinning detonation wave consists of at least two parts, meeting along the dia. of the tube, as postulated by Shchelkin and Zeldovich. A. SCHOFIELD

541.127.4

505. Equilibrium and the rate laws. C. A. HOLLINGSWORTH. Letter in *J. chem. Phys.*, **20**, 1649–50 (*Oct.*, 1952).

A mathematical analysis of necessary conditions for the equilibrium expression obtained by equalizing the forward and reverse rate expressions to hold for all activities and temperatures for which the equilibrium constant derived from mass law holds. F. LACHMAN

541.127.4 : 534.23

506. On the relaxation time of equilibrium systems as related to ultrasonic absorption and reaction kinetics. M. MANES. Letter in *J. chem. Phys.*, **20**, 1658 (*Oct.*, 1952).

Ultrasonic absorption in acetic acid is due to a perturbation of the equilibrium between monomeric and dimeric forms. It can be shown that near chemical equilibrium the relaxation time is the reciprocal of the (first-order) rate constant for the process. The concept of the relaxation time for an equilibrium system enables one to calculate the energy absorption coefficient per wavelength for various postulated rate laws. H. H. GREENWOOD

541.128

507. On promotion in heterogeneous catalysis. L.D'OR AND A. ORZECHOWSKI. *C.R. Acad. Sci.* [*Paris*] **235**, 368–70 (*Aug.* 4, 1952). *In French.*

The activity of a Ni catalyst promoted by contents of cerium oxide varying from 0–100% has been measured by means of its effect on the rate of dehydrogenation of phenol. Both the total area, and the area of the Ni itself, have been estimated (using the fact that only Ni adsorbs H_2). In the most active catalysts the activity per unit area of the Ni is comparable with that of the pure Ni, but in the catalyst containing a low content of Ni the activity per unit area is low; this probably signifies the presence of an inactive (amorphous?) form of Ni. S. J. GREGG

541.128

508. Further researches on promotion in heterogeneous catalysis. L.D'Or and A. Orzechowski. *C.R. Acad. Sci.* [*Paris*] **235,** 430–2 (*Aug.* 11, 1952) *In French.*

The adsorption of hydrogen at −195°C can be used as a measure of the area of catalytically active Ni present in cerium oxide-promoted catalysts. It is shown that the catalytic activity per unit area of active Ni never exceeds that of pure Ni and is often less, i.e. the promoter does not act by exalting the "quality" of the surface of the catalyst, but rather by increasing the area of the catalyst per gram of Ni.

S. J. GREGG

ELECTROCHEMISTRY 541.13

541.135.5

509. Characteristics of electrolytes given by small amounts of alumina dissolved in fused cryolite. L. Ferrand. *Bull. Soc. Franç. Elect.* (*Sér.* 7) **2,** 477–80 (*Aug.*, 1952) *In French.*

The physico-chemical properties of electrolytes are discussed wherein small amounts of alumina are dissolved in fused cryolite. From their degree of dissociation and conductivity, deductions are made with respect to the course of electrolysis, stability, and specific consumption of energy. There are 2 data tables and 9 refs.

H. H. HODGSON

541.135.5

510. Calculation of the concentration of atomic hydrogen at a cathode. H. W. Salzberg and S. Schuldiner. Letter in *J. chem. Phys.*, **20,** 1495 (*Sept.*, 1952).

In recent papers [see Abstr. 6846 (1952)] Bockris *et al.* have deduced a formula for the concentration of hydrogen atoms on the surface of a cathode, and therefrom have stated that removal of atomic hydrogen from the surface must proceed by an electrochemical mechanism, viz., $MH + H_3O^+ + e \rightarrow M + H_2O + H_2$. It is now shown that the formula is incorrect both in concept and detail, and that the mechanism cannot be operative at currents of an amp/cm² and up, or rate-determining. Unpublished data of Schuldiner on bright Pt indicate that the electrochemical mechanism is not operative on Pt in acids at high c.d., where the slope of the overvoltage — log c.d. curve is 0·12.

H. H. HODGSON

541.135.5

511. Hydrogen overvoltage and atomic hydrogen electrodes. P. Van Rysselberghe. *J. chem. Phys.*, **20,** 1522–3 (*Oct.*, 1952).

The fundamental thermodynamics and kinetics of hydrogen overvoltage are re-examined and improved. A precise definition of the transfer coefficient is given, the significance of the free energy of activation is discussed, and additional theoretical support is given for the interpretation of hydrogen overvoltage as being due to the establishment of reversible atomic hydrogen electrodes.

A.

541.135.5

512. Reduction potentials and unsaturation energy changes in electrode reactions leading to the formation of acridyl radicals. N. S. Hush. Letter in *J. chem. Phys.*, **20,** 1660–1 (*Oct.*, 1952).

The reduction of ionized amino acridine to an ionized acridyl is considered. As the rates of all other reactions affecting the concentrations concerned are small, the change in half-wave potential may be considered proportional to the change in exothermicity. The latter is approximately equal to the change in unsaturation energy, which can be calculated by the LCAO . MO method. If this is plotted against observed values of the half wave potential for several reactions of the same type, a straight line is obtained, as was predicted.

A. J. TAYLOR

PHOTOCHEMISTRY . RADIATION CHEMISTRY 541.14/15

541.14

513. Photobromination of pentane. M. S. Kharasch, W. Zimmt and W. Nudenberg. Letter in *J. chem. Phys.*, **20,** 1659 (*Oct.*, 1952).

Contrary to the finding of Williams and Hamill (1950), the authors found that, among the products of the vapour phase bromination of *n*-pentane at 80°C, more than 94% of the theoretically possible amount of Br used was recovered as amyl bromides.

F. LACHMAN

541.14 : 534.23

514. Explaining some chemical effects of ultrasonics. H. H. Rust. *Angew. Chem.*, **64,** *No.* 6, 162–3 (1952) *In German.*

It has been found that the formation of O in aqueous liquids and the fission of the molecular bond of CCl_4 dissolved in water, due to ultrasonics, are related to the existence of tiny gas bubbles oscillating in resonance. The above chemical effects are not observed when the liquids are degassed or when the standing waves are eliminated.

F. LACHMAN

541.15

515. Reactions of methane with iodine activated by radiative neutron capture. J. F. Hornig, G. Levey and J. E. Willard. *J. chem. Phys.*, **20,** 1556–60 (*Oct.*, 1952).

About 50% of the I^{128} atoms formed by the $I^{127}(n, \gamma)I^{128}$ reaction in gaseous mixtures of 0·2 mm of iodine and 400 mm of methane enter combination as methyl iodide, whereas much less than 1% of iodine atoms produced simultaneously by the photochemical dissociation of the iodine do so. By contrast, about 1% of the I^{128} formed by the $I^{127}(n, \gamma)I^{128}$ reaction in gaseous mixtures of iodine and ethyl iodide enters organic combination. The solubility of iodine in pure liquid methane is less than 10^{-10} m/l but as much as 3×10^{-5} m/l may be dissolved when air has been allowed to condense in the methane. In such solutions I^{128} from the $I^{127}(n, \gamma)I^{128}$ reaction is able to enter organic combination as methyl iodide, ethyl iodide, and higher boiling material.

A.

541.15

516. The radiation decomposition of organic molecules. J. B. Birks. Letter in *J. chem. Phys.*, **20,** 1655–6 (*Oct.*, 1952).

It is suggested that radiation decomposition is due

to reabsorption of primary photons by the organic molecules, which decompose photochemically. On this basis equations, e.g. for ionic yield, which are comparable with those of Alder and Eyring [Abstr. 6834 (1952)] can be derived. The hypothesis is used to explain the difference between yields from X-rays and α-particles. It can also be applied to non-aqueous solutions. C. B. ALLSOPP

DISPERSIONS . COLLOIDS . ADSORPTION 541.18

541.18.047

517. Micro-spherical aggregation of barium sulphate. D. I. STOCK. Letter in *Nature* [*London*] **170,** 423 (*Sept.* 6, 1952).

Precipitated barium sulphate, after drying for several days at 110°C, was shaken with pure dry benzene in an automatic shaker. After 24 hrs the solid had aggregated completely into spheres of 1–0·5 mm dia. It is suggested that the phenomenon may be due to the fact that this compound has a hydrophilic surface and thus would tend to present a minimum surface per unit volume to the benzene. J. IBALL

541.183.2 : 539.61

518. On the theory of dipole interactions with metals. S. J. CZYZAK. *Amer. J. Phys.*, **20,** 440–6 (*Oct.*, 1952).

The classical and quantum-mechanical interactions of molecular dipoles and metallic surfaces are derived and numerical calculations given for several molecule-metal pairs. The results represent the permanent dipole contributions to the total van der Waals interaction. The bearing of the dipole interactions on the problem of adhesion is discussed. A.

CHEMICAL STRUCTURE 541.2/.6

541.23 : 539.155.4

A comparison of the chemical and physical atomic weight values of the monoisotopic elements. *See Abstr.* 392

541.24 : 535.43

519. Molecular weight of glycogens determined by a light-scattering method. B. S. HARRAP AND D. J. MANNERS. Letter in *Nature* [*London*] **170,** 419–20 (*Sept.* 6, 1952).

The molecular weights of glycogens from rabbit liver, rabbit muscle, cat liver, foetal sheep liver, *Tetrahymena pyriformis*, and *Ascario lumbricoides* have been determined by the turbidity method. Values lie between $2{\cdot}8\times10^6$ and $14{\cdot}8\times10^6$ and are generally higher than those determined by other methods. This may be due to the fact that the light-scattering method gives weight-average values, and the presence of small amounts of higher molecular weight material will cause considerably higher final results. The dissymmetry of light-scattering shown by some of the glycogens examined (but not by rabbit muscle glycogen or foetal sheep liver glycogen) may also be due to the presence of molecules of greater molecular weight. A. J. MEE

541.24 : 535.43

520. On the use of unfiltered light in determining molecular weights by light scattering. M. KERKER. Letter in *J. chem. Phys.*, **20,** 1653–4 (*Oct.*, 1952).

To avoid difficulties consequent upon the use of filtered light for the measurement of light scattering, e.g., the reduction of intensity of the light on passing through the filter, it is possible to use unfiltered light to obtain the same information about molecular weights. An expression for the molecular weight is given involving the response of the photo-tube and the intensity of the incident beam taken over the entire spectrum used. These quantities can be determined by the use of the monochromator of a Beckmann spectrophotometer. A. J. MEE

541.61

521. Aromaticity of conjugated monocyclic hydrocarbons. K. MISLOW. Letter in *J. chem. Phys.*, **20,** 1489–90 (*Sept.*, 1952).

It has been suggested that such compounds as C_nH_n with $n > 8$ and $n = 4m + 2$, where m is an integer, might exist in unstrained and coplanar configurations. This assumption ignores the hydrogen interferences. In most cases the inner and sometimes the outer H atoms must repel each other considerably, so that the coplanarity and the aromatic character of the compound are disturbed. Several examples are given. It is found that unstrained coplanar structures are likely to exist for very big molecules ($n \geqslant 30$). A. J. TAYLOR

541.632 : 535.343.4

Rotational isomerism as a general property of alkyl nitrites. *See Abstr.* 132

541.67

522. Magnetic susceptibility and the structures of the peroxides. A. B. NEĬDING AND I. A. KAZARNOVSKIĬ. *Zh. fiz. Khim.*, **26,** *No.* 8, 1167–72 (1952) *In Russian.*

Using the Gouy method the susceptibilities of solutions of H_2O_2 in water at concentrations of 6–98% and at temperatures of −5° to −183° were measured. Solid 98% H_2O_2 was also examined. The compound was found to be diamagnetic under all conditions, 100% H_2O_2 having a molar susceptibility at room temperature of $-17{\cdot}7\times10^{-6}$. CaO_2, SrO_2 and BaO_2 had molar susceptibilities at 18° of −23·8, −32·3 and $-40{\cdot}6\times10^{-6}$ respectively. A mean molar susceptibility for the peroxide ion of $(-17 \pm 1)\times10^{-6}$ was obtained using known values for the metallic contributions. Magnetic data are in agreement with X-ray findings that the peroxide ion has a structure like that in an isolated H_2O_2 molecule, that the structure is not like that of the O_2 molecule and that the two oxygen atoms are identical. H_2O–O is excluded as a possible structure for hydrogen peroxide. A. L. MACKAY

LABORATORY APPARATUS 542.1/.7

542.48 : 539.155.2

523. Optimal flow in fractionating columns for isotope separation. I. DOSTROVSKY, J. GILLIS AND B. VROMEN. Letter in *Bull. Res. Coun. Israel*, **2,** 68–9 (*June*, 1952).

The theory is outlined of the optimum rate of flow

observed in certain types of packed distilling columns and due to the fact that, while the enrichment of rare isotopes obtained decreases rapidly with an increase of the ratio of the production to flow, the separating efficiency of the columns is inversely proportional to the rate of flow. F. LACHMAN

542.73

524. A simple gas-flow-control of high efficiency. D. H. JAMES AND C. S. G. PHILLIPS. *J. sci. Instrum.*, **29**, 362–3 (*Nov.*, 1952).

The operation of the device depends upon the maintenance of a constant pressure across a choke, by means of a blow-off through a sintered glass disk. A very constant flow can be delivered, even under widely varying conditions of pressure in the receiving apparatus. A.

CHEMICAL PROCESSES 542.9

542.952.6

525. Modified distribution functions for ethylene oxide-type polymerizations. L. GOLD. Letter in *J. chem. Phys.*, **20**, 1651–2 (*Oct.*, 1952).

An examination of identification of these functions without the restriction of identical reaction rates. J. JACOBS

CHEMICAL ANALYSIS 543/545

545.37

526. Cathode-ray oscilloscopic investigation of phenomena at polarizable mercury electrodes. J. W. LOVELAND AND P. J. ELVING. *Chem. Rev.*, **51**, 67–117 (*Aug.*, 1952).

This review discusses the theory, experimental principles, applications and results of oscillographic recording to phenomena at polarized mercury electrodes, including oscillographic polarography. Oscillographic methods are found to be well adapted for the study of the kinetics of chemical reactions, when one or more of the reactants or products are electroactive under the experimental conditions, and for the investigation of the reversibility–irreversibility of electrode reactions. Film formation, due to adsorption–desorption of non-electrolytes at the surface of a mercury electrode, resulting in capacitive charges, is readily followed, and current-time, current-potential and potential-time methods for the oscillographic observation of phenomena at stationary, dropping and streaming mercury electrodes are valuable for the study of adsorption and redox phenomena. There are 80 references. H. H. HODGSON

545.37

527. Tensammetry: a method of investigating surface phenomena by a.c. current measurements. B. BREYER AND S. HACOBIAN. *Austral. J. sci. Res. A*, **5**, 500–20 (*Sept.*, 1952).

A new type of investigation into surface phenomena, "tensammetry," has been developed by superimposing a small sinusoidal a.c. voltage upon the direct potential applied to a dropping mercury electrode in the presence of surface active substances and measuring the resultant a.c. currents. Wave shaped current-voltage curves are thus obtained which have their origin in adsorption processes occurring at the electrode. These waves are attributed to the movement of surface active molecules in the region of "active space" near the electrode without actual electron transfer across the electrode boundary; that is, the electrode remains polarized with respect to d.c., but is depolarized with respect to a.c. The general properties of tensammetric waves of a number of organic compounds together with their effects on one another and on d.c. and a.c. polarographic waves have been investigated. The theoretical basis and the fundamental equations governing the tensammetric process are derived and discussed. A.

545.824

528. Some problems in the analysis of steels by X-ray fluorescence. E. GILLAM AND H. T. HEAL. *Brit. J. appl. Phys.*, **3**, 353–7 (*Nov.*, 1952).

The measurement of the proportion of elements of atomic numbers higher than 20 in steels by X-ray fluorescence using a Geiger counter spectrometer has been investigated, primarily with a view to determining the suitability of the method as a rapid means of analysis during the steel-making process, particularly for high-alloy steels. A monitoring system to compensate for fluctuations in X-ray output is described and shown to increase the accuracy, though it gives higher variances than theoretical ones obtained by assuming a Poissonian distribution of counting events, and shows "drift" over long periods. From measurements on some iron/chromium/nickel steels it appears that unless a very powerful X-ray tube is used the method gives quick results of high accuracy only when more than about 10% of the alloying element is present. It is also shown that in some cases standard diagrams would have to be drawn up to allow for "mutual fluorescence." Certain possible improvements are noted. An appendix gives the theory of this X-ray fluorescence analysis. A.

CRYSTALLOGRAPHY 548

548.0 : 531.754

529. Determination of protein crystal densities. B. W. LOW AND F. M. RICHARDS. *Nature* [*London*] **170**, 412–13 (*Sept.* 6, 1952).

A micro-balance is described for weighing the crystal in the mother liquor. The volume is estimated from measurements of the dimensions from a photomicrograph. A value of $1{\cdot}144 \pm 0{\cdot}066$ was obtained for β-lactoglobulin, as compared with $1{\cdot}147 \pm 0{\cdot}003$ by the gradient tube method. A. R. STOKES

548.1

530. The direct-inspection method in systems with a principal axis of symmetry. F. G. FUMI. Note in *Acta cryst.*, **5**, 691–4 (*Sept.*, 1952).

See Abstr. 3999 (1952). The method is applied to

find the relations between the components of a polar or axial fourth-order tensor in any trigonal or hexagonal symmetry group. A. R. STOKES

548.522

531. Ice crystals of spiral form grown from the vapour. B. J. MASON AND P. G. OWSTON. Note in *Phil. Mag.*, **43**, 911–12 (*Aug.*, 1952).

Describes some crystals of spiral form found growing in a refrigerator. They are not an example of growth round a screw dislocation: an explanation is suggested. Piezo-electric and pyro-electric properties could not be detected. A. R. STOKES

548.574

532. Observations on growth and etch phenomena on haematite (Fe_2O_3) crystals. A. R. VERMA. *Proc. Phys. Soc.* [*London*] *B*, **65**, 806–11 (*Oct.*, 1952).

Of the many growth patterns observed, the simplest are the elementary "molecular growth spirals" in accordance with the theory of Burton, Cabrera and Frank. The step height between the successive arms of an elementary spiral has been measured by the application of multiple beam interference fringes and is shown to be equal to the X-ray value of the repeat distance. More complex growth patterns are illustrated and discussed. The etch figures reported are also of molecular thicknesses and consist of a very large number ($\sim 10^7/cm^2$ of the crystal surface) of similarly oriented small triangular figures, and some more complex shapes. A.

MOLECULAR AND X-RAY CRYSTALLOGRAPHY 548.7

548.7

533. On the theory of kinking. F. C. FRANK AND A. N. STROH. *Proc. Phys. Soc.* [*London*] *B*, **65**, 811–21 (*Oct.*, 1952).

The concept of a kink-band is introduced. It is a thin plate of sheared material in a crystal, transverse to a slip direction, bounded by opposite "tilt walls" of dislocations. It is shown that if the angle of kinking shear γ exceeds a critical value (estimated to be $3\frac{1}{2}°$) the stress concentration at the edges of the band is sufficient for the creation of new dislocation pairs or loops, and that if the applied stress exceeds a certain value, inversely proportional to the square root of the diameter of the kink-band, the kink-band will grow by this process. The stress field of a kink-band is similar to that of a slip-band, a plate of deformation twin, or a crack under tangential stress. In suitable circumstances these may act as sources for each other. The successive generation of kink-bands, inside each other, from the same source, will produce a kink of the kind experimentally observed. A.

548.7 : 537.228.1 : 537.226.2

Piezoelectricity, ferroelectricity, and crystal structure. *See Abstr.* 209

548.7 : 537.311.33

534. Electronic states in crystals under large over-all perturbations. P. FEUER. *Phys. Rev.*, **88**, 92–100 (*Oct.* 1, 1952).

Solutions of the three-dimensional Schrödinger equation are discussed for a potential which is the sum of a potential with the periodicity of the crystal lattice plus a perturbing potential. A general theory of large over-all perturbations, such that the energy lies close to one permitted band in one region of the crystal and close to a second permitted band in another, is developed. The theory is then applied to a one-dimensional crystal in a uniform electric field, using the narrow band approximation; the probability for an electron to cross a forbidden energy band is calculated. These results are considered in connection with the interpretation of the current-voltage characteristic of an *N–P* junction of Ge at high electric fields. A.

548.7 : 539.219.2

535. Effect of internal strains on linear expansion, X-ray lattice constant, and density of crystals. P. H. MILLER, JR, AND B. R. RUSSELL. *J. appl. Phys.*, **23**, 1163–9 (*Oct.*, 1952).

General formulae are derived for the shift in X-ray diffraction maxima due to small distortions in simple cubic crystals. The special case of radial distortions due to lattice defects is considered in detail; it is found that the relative change in lattice constant computed from the shift in diffraction maxima is of the order of magnitude of the defect concentration and larger by as much as 100% than the linear expansion when the concentration of defects is of the order of 1% of less. A comparison is made of lattice constant, linear expansion and density expected in crystals containing Frenkel defects, Schottky defects, or *F* centres. A.

548.7 : 539.389

536. The quenching-in of lattice vacancies in pure gold. J. W. KAUFFMAN AND J. S. KOEHLER. Letter in *Phys. Rev.*, **88**, 149 (*Oct.* 1, 1952).

An increase Δr was observed in the resistance of wires when quenched from a high temperature T (690–920°C) to liquid N_2 temperatures, and is attributed to frozen-in vacancies. It was calculated from the increase of Δr with T that the energy to form a vacancy lies between 1 and 2 eV and from the rate at which Δr decays on annealing (at $-21{\cdot}7$ and at $-2{\cdot}7$°c) that the energy required to move a vacancy is $0{\cdot}4 \pm 0{\cdot}14$ eV. A. D. LE CLAIRE

548.73/.74 : 539.26/.27

X-ray and electron investigation of materials. *See Abstr.* 485–7

548.732 : 537.531 : 535.34

537. The angular shift of the transmitted X-ray beam near the Bragg angle. L. C. BROWN, G. L. ROGOSA AND G. SCHWARZ. Letter in *J. appl. Phys.*, **23**, 1054 (*Sept.*, 1952).

Experiments on calcite crystals confirm the predictions of Ramachandran [Abstr. 5439 (1952)] concerning the asymmetry of the transmission curve and the slight difference between the positions of maximum transmission and of maximum reflection.

A. R. STOKES

548.733

538. A low-temperature X-ray powder camera. N. C. TOMBS. *J. sci. Instrum.*, **29**, 364 (*Nov.*, 1952).

A Unicam 19 cm circular powder camera has been modified so as to permit streaming of a cooling liquid, such as liquid air, over the rod-type specimen during a photographic exposure. The specimen projects

upwards from the specimen holder located in the camera base, and the cooling liquid enters the camera through a metal capillary passing through a light-trap in the top of the camera lid. Various specimen temperatures can be obtained by use of different liquefied gases, or of a pre-cooled inert liquid. The sharpness of the X-ray reflections obtained shows that the variation of specimen temperature during an exposure is not more than a few degrees. A.

548.734

539. Setting a single crystal by non-equatorial X-ray reflections. A. L. MACKAY. Note in *Acta cryst.*, **5**, 691 (*Sept.*, 1952).

To set a crystal giving prominent row, but not layer, lines to rotate about a sixfold axis, three 5° oscillation photographs at 120° intervals were taken on the same film. By slightly rotating the cassette corresponding row lines were separated and their mutual displacements were used to calculate arc corrections. A. L. MACKAY

548.734

540. The effect of a low absorption coefficient on X-ray spectrometer measurements. D. T. KEATING AND B. E. WARREN. *Rev. sci. Instrum.*, **23**, 519–22 (*Oct.*, 1952).

In X-ray spectrometer measurements with a flat sample, low absorption produces an asymmetric broadening and displacement of the measured peak. The distortion of the peak due to low absorption can be corrected by an expression involving only the measured peak shape and its derivative. The distortion can also be corrected by the Stokes method of Fourier analysis, and values of the coefficients are given for a suitable range of experimental conditions. A.

548.735

541. Effect of vertical divergence on the displacement and breadth of X-ray powder diffraction lines. J. N. EASTABROOK. *Brit. J. appl. Phys.*, **3**, 349–52 (*Nov.*, 1952).

A treatment is given of the aberrations caused by the extension of the X-ray source, specimen and receiving slit normal to the plane of the camera or spectrometer. A detailed examination is made of the aberrations which occur: (*a*) when the height of the specimen is the sole cause, and (*b*) when the vertical divergence of the X-ray beam is limited by Soller slits, the displacement and profile of the line being determined in each case. It is shown that vertical mis-alignment of a spectrometer can cause an additional broadening of the lines, especially in the back-reflection region. A.

548.735

542. X-ray diffraction by structures consisting of bundles of parallel chains displaced along their axis. E. E. GALLONI. *An. Acad. Brasil Ciênc.*, **24**, *No.* 2, 203–12 (1952) *In German*; Substantially same as *Rev. Un. Mat. Argentina*, **14**, 338–49 (1950) *In Spanish*.

Theoretical. [In the opinion of the abstractor the calculation is incorrect from eqn. (5) onwards.] A. J. C. WILSON

548.735.4

543. On an application of inequality methods to centrosymmetric crystals with partly known structures. Y. OKAYA AND I. NITTA. Note in *Acta cryst.*, **5**, 687 (*Sept.*, 1952).

A method is described whereby the inequalities of Harker and Kasper and of the authors [Abstr. 9172 (1952)] can be applied to greater advantage if the positions of some of the atoms are known. A. B. STOKES

548.735.4

544. Application of our linear inequalities and some remarks on B. S. Magdoff's paper on "Forbidden reflections in the Harker–Kasper inequalities." Y. OKAYA AND I. NITTA. Note in *Acta cryst.*, **5**, 687–8 (*Sept.*, 1952).

Magdoff's application of the Harker–Kasper inequalities [Abstr. 9172 (1952)] is modified by the substitution of the Okaya–Nitta inequalities (Abstr. 6577 (1951)] which are claimed to be more convenient. A. R. STOKES

548.735.4

545. Some remarks on the relation between the Harker–Kasper inequality and the Okaya–Nitta linear inequalities. K. SAKURAI. Note in *Acta cryst.*, **5**, 697 (*Sept.*, 1952).

It is shown that the latter inequalities [Abstr. 9172 (1952)] are only slightly less powerful than the former [Abstr. 3015 (1948)] in limiting the phases of structure factors. A. R. STOKES

548.736.3

546. On the crystal structure of manganese nitrides. Z. NISHIYAMA AND R. IWANAGA. *Mem. Inst. Sci. Industr. Res. Osaka Univ.*, **9**, *No.* 13, 74–5 (1952).

Powder photographs of alloys made by nitriding electrolytic Mn powder with NH_3 at 600° for 3 hrs contain lines attributed to a new phase θ, face-centred cubic with $a = 4{\cdot}435$ Å (?kX), containing ~21 wt%N. A. J. C. WILSON

548.736.3

547. On the Fe–Cr superlattice. M. TAGAYA, S. NENNO AND Z. NISHIYAMA. *Mem. Inst. Sci. Industr. Res. Osaka Univ.*, **9**, *No.* 14, 76–9 (1952).

An unsuccessful search was made for a CsCl or other superlattice in alloys of approximate composition FeCr, Mn radiation being used to enhance the difference in scattering power between Fe and Cr. No superlattice lines were found in any cubic alloy after various heat treatments; with appropriate treatment the complex σ phase appeared. A. J. C. WILSON

548.736.3

548. Crystal structure of platinum dioxide. R. H. BUSCH, E. E. GALLONI, J. RASKOVAN AND A. E. CAIRO. *An. Acad. Brasil Ciênc.*, **24**, *No.* 2, 185–201 (1952) *In German*.

PtO_2 was prepared by heating $H_2PtCl_6 + NaNO_3$ at temperatures up to 550°C for times up to 3 months. Powder photographs of the samples varied greatly in sharpness and number of lines, samples prepared by heating at 350°C for 3 months giving the sharpest and most detailed pattern. All photographs could be indexed on a hexagonal cell, $a = 3{\cdot}08$, $c = 4{\cdot}19$ Å. The variation of intensity was systematic, lines with high l index being weak even in the best sample and fading out in the poorly crystalline samples. The suggested structure consists of parallel chains of

–Pt–O–O–Pt–O–O–Pt– with Pt in 000, O in $\pm 00u$, $u \sim 0{\cdot}34$. The disorder leading to weakening of lines with high l index is a random displacement of chains parallel to their length. A. J. C. WILSON

548.736.3 : 669

549. Phase changes in silver-tin amalgams. J. C. MOFFETT, G. RYGE AND A. G. BARKOW. *J. appl. Phys.*, **23**, 1188–9 (*Oct.*, 1952).

The study of a continual series of X-ray diffraction patterns of a 60% Hg + 40% Ag_3Sn sample, taken from the time of trituration, suggests the following series of reactions for the setting process: $Ag_3Sn + Hg \rightarrow \gamma_1 + \gamma_2 + Ag_3Sn$ (instantaneous); $\gamma_1 + \gamma_2 + \gamma \rightarrow \gamma_1 + \gamma_2$; $\gamma_1 + \gamma_2 \rightarrow \gamma_1 + \gamma_2 + \beta_1$.

A. D. LE CLAIRE

548.736.4 : 537.226.2

550. The non-polarity of sodium niobate. P. VOUSDEN. Note in *Acta cryst.*, **5**, 690 (*Sept.*, 1952).

A reply to criticisms of an earlier paper [P. Vousden, Abstr. 1345 (1952)], proving that twinning does not interfere with the determination of the space group, and explaining the ferroelectric properties by assuming the induction of a polar structure by a strong electric field. C. TURNER

548.736.5

551. The crystal structure of $U(OH)_2SO_4$. G. LUNDGREN. *Ark. Kemi*, **4**, *Paper* 30, 421–8 (1952).

Isotypic with $Th(OH)_2SO_4$ [Abstr. 2181 (1951)]. The parameters of the metal atoms are found to be the same, and those of the S and O atoms to be within $\pm 0{\cdot}01$, which is less than their experimental error. The cell dimensions are $a = 11{\cdot}572$, $b = 5{\cdot}926$, $c = 6{\cdot}969$ Å, all $\pm 0{\cdot}005$ Å. A. J. C. WILSON

548.736.6

552. Crystal structures of Pd_2Si, Pt_2Si, Pd_2Ge and Pt_2Ge. K. SCHUBERT AND K. ANDERKO. Note in *Naturwissenschaften*, **39**, *No.* 15, 351 (1952) *In German.*

Pt_2Si is tetragonal, with a structure similar to Fe_2B. The others are of the hexagonal (trigonal) Fe_2P type, with the parameters (in kX): Pd_2Si, $a = 6{\cdot}48$, $c = 3{\cdot}44$; Pd_2Ge, $a = 6{\cdot}76$, $c = 3{\cdot}45$; Pt_2Ge, $a = 6{\cdot}74$, $c = 3{\cdot}54$. The "position correlation of the valence electrons" [Abstr. 9119 (1950)] is discussed. A. J. C. WILSON

548.737

553. The crystal structure of sucrose. C. A. BEEVERS, T. R. R. MCDONALD, J. H. ROBERTSON AND F. STERN. Note in *Acta cryst.*, **5**, 689–90 (*Sept.*, 1952).

The space group is $P2_1$, the cell dimensions are: $a = 10{\cdot}89$, $b = 8{\cdot}69$, $c = 7{\cdot}77$ Å, $\beta = 103°$. A table of atomic parameters, a b-axis Fourier projection and a diagram of the structure are given.

C. TURNER

548.737

554. Globulite units in protein crystals? D. WRINCH. Note in *Acta cryst.*, **5**, 694–5 (*Sept.*, 1952).

Curves of X-ray scattering by horse methemoglobin and myoglobin, obtained by circular smoothing in reciprocal space, show maxima and minima which support the hypothesis of globulite units. A. R. STOKES

548.737

555. The crystal structure of tetraphenyl–germanium and the structure analysis of the tetraphenyl compounds of elements in the fourth group. I. G. ISMAILZADE. *Zh. fiz. Khim.*, **26**, *No.* 8, 1139–43 (1952) *In Russian.*

Assuming conventional atomic radii and bond lengths, the geometrical packing of two molecules of $Ge(C_6H_6)_4$ into their tetragonal unit cell was examined. The two general parameters, ϕ, the angular rotation of the molecule round the z-axis, and ψ, the angular rotation of the phenyl groups round the Ge–C bonds reckoned from the position in which the phenyl ring makes an angle of 35°16′ with the XY plane, were found to be 6°45′ ± 15′ and 52°30′ respectively. XY Fourier syntheses were carried out for the corresponding C, Si, Ge, Sn and Pb compounds, the values of ϕ and ψ obtained agreeing well with geometrical estimates. In the C isomorph the C–C–C bond angles at the central carbon atom were found to be distorted by 3°30′. A. L. MACKAY

GEOPHYSICS 55

550.341

556. Detection of *S* waves in the Earth's inner core. K. E. BULLEN AND T. N. BURKE-GAFFNEY. Letter in *Nature* [*London*] **170**, 455 (*Sept.* 13, 1952).

Seismograms have been searched for the low amplitude phase PKJKP but no definite onsets have been found. The rather critical conditions in which the phase, if it exists, might be found are discussed.

A. H. COOK

550.361

557. On the thermal properties of the Earth's interior. R. J. UFFEN AND A. D. MISENER. Letter in *Proc. Phys. Soc.* [*London*] *B*, **65**, 742 (*Sept.*, 1952).

Existing seismic data combined with the molecular theory of solids enable more reliable estimates to be made of the thermal state of the earth's interior. Computed values of adiabatic gradient indicate a decrease with depth in good agreement with previous work of Verhoogen (1951); but the melting point estimates give a value at 2000 km of 5000°K, about half that found by Jeffreys from lab. data (1929). Also the adiabatic gradient in the core ($\tau = 5000$°K at boundary) is found less than Bullard's estimate (1950) by a factor of four. D. R. BARBER

550.93 : 539.165

K^{40} radioactive decay: its branching ratio and its use in geological age determinations. *See Abstr.* 410

ATMOSPHERE . METEOROLOGY 551.5

551.508.1 : 537.534.72

558. Radiofrequency mass spectrometer for upper air research. J. W. TOWNSEND, JR. *Rev. sci. Instrum.*, **23**, 538–41 (*Oct.*, 1952).

Electronic circuits have been designed for the

Bennett type of radiofrequency mass spectrometer so that it may be used in an experiment devised to obtain the composition of the upper atmosphere. The rocket-borne spectrometer samples the spectrum between mass numbers 48 and 5 once per second with a resolution of one part in twenty-five. Data may be obtained between pressure limits of 8×10^{-4} mm Hg and 2×10^{-6} mm Hg, corresponding to ambient pressures between 100 km and 160 km, respectively. The entire instrumentation weighs less than 50 pounds and occupies a total of 1·4 cubic feet. A.

551.508.19 : 523.77

559. Infra-red solar spectroscopy in a high-altitude aircraft. J. YARNELL AND R. M. GOODY. *J. sci. Instrum.*, **29**, 352–7 (*Nov.*, 1952).

An i.r. solar spectrometer and a fast electronic heliostat have been designed to enable solar spectra to be recorded at the base of the stratosphere. The general characteristics of the apparatus, and some of the major difficulties encountered, are described. A.

551.510.535

560. A method for studying sporadic-*E* clouds at a distance. O. G. VILLARD, JR, A. M. PETERSON AND L. A. MANNING. Letter in *Proc. Inst. Radio Engrs*, **40**, 992–4 (*Aug.*, 1952).

Involves an observing technique whereby the growth, motion and disappearance of sporadic-*E* clouds of ionization can be studied. This depends on the phenomenon that propagation via clouds of sporadic-*E* ionization results in most of the back-scattered energy returning from the earth's surface and not from the ionosphere. Thus these sporadic-*E* clouds can be tracked by a pulsed h.f. transmitter and receiver associated with a rotatable directional aerial, preferably working on a frequency high enough to avoid any regular-layer reflection back to the earth's surface. Scatter-echoes from the earth's surface due to any sporadic-*E* clouds that may exist can then be displayed on a plan position indicator, and the position of these clouds derived therefrom. Illustrations of such P.P.I. indications are given.

A. A. LINSELL

551.510.535

561. Scatter-sounding: a new technique in ionospheric research. O. G. VILLARD, JR AND A. M. PETERSON. *Science*, **116**, 221–4 (*Aug.* 29, 1952).

It is suggested that ionospheric investigations may be considerably extended in range from one station by the use of echoes back-scattered from the ground after reflection at oblique incidence at the *E* or *F* regions. It is found that pulse lengths about 10 times those commonly used for vertical-incidence sounding received on conventional communication equipment provide satisfactory ground back-scattered echoes for ionospheric reflecting points as far away as 1250 mls. (*F*-layer) or 600 mls. (*E*-layer). Possible applications are considered.

G. M. BROWN

551.510.535

562. Ionospheric measurements at oblique incidence over eastern Australia. M. STROHFELDT, R. W. E. MCNICOL AND G. DE V. GIPPS. *Austral. J. sci. Res. A*, **5**, 464–72 (*Sept.*, 1952).

An account is given of night observations of oblique-incidence pulse transmissions on 5·8 M[illegible] over a baseline of 763 km, using a responder tec[illegible] nique. The experiment aimed at measuring appare[illegible] path lengths as a guide to the identification of th[illegible] reflecting layer in the ionosphere. The charac[illegible] teristics of beacon triggering are discussed in relation[illegible] to the echo system received after ionospheric reflection[illegible] A correlation of E_s occurrences as observed at oblique[illegible] incidence and vertical incidence near the midpoint of[illegible] the trajectory was effected, and certain characteristics[illegible] of the E_s layer are presented. Unusual records of[illegible] Pedersen rays are reproduced and sudden height in-[illegible] creases and diffuseness of F_2 echoes are discussed.[illegible] A check on the oblique-incidence theory using a[illegible] Millington transmission curve on vertical-incidence[illegible] $h'f$ records yielded reasonable agreement between[illegible] measured and deduced reflection heights, although[illegible] there is evidence of a tendency for the predicted[illegible] obliquity factor to be too low. A rough analysis of[illegible] oblique-incidence penetrations yielded an average[illegible] value for the frequency separation of the magneto-[illegible] ionic M.U.F.'s close to half the gyromagnetic[illegible] frequency. A.

551.510.535

563. Production of the *E*-layer in the oxygen dissociation region in the upper atmosphere. D. C. CHOUDHURY. *Phys. Rev.*, **88**, 405–8 (*Oct.* 15, 1952).

Starting with the generally accepted theory that the *E*-layer is formed by ionization of O_2 in the region of its dissociation, the probable value of the absorption cross-section of O_2 for this ionization is calculated by utilizing the height distribution of O_2 (in the transition region) as recently obtained by Moses and Wu. It is found that, depending upon the temperature gradient and the boundary temperature chosen for the region of dissociation, the necessary absorption cross-section varies from 3×10^{-19} cm² to 9×10^{-18} cm². Hence, it follows that for the two current hypotheses of *E*-layer ionization, namely, pre-ionization by solar rays in the wavelength range 900 Å–1000 Å (Nicolet) and ionization by high-energy photons emitted from the solar corona (Hoyle and Bates), the ionization cross-section of O_2 should also lie within this range. For the former, the rate of ion production (as obtained by application of simple Chapman formula and assuming the sun to be radiating like a blackbody) appears to be one hundred times more than the observed rate. The discrepancy is removed if it is assumed that of the molecules excited to the pre-ionization levels by absorption, only a small fraction (one in a hundred) undergoes ionization. For the high-energy photons it is found that in order to have the necessary absorption cross-section, the energy should be 181 eV rather than 325 eV as obtained by Hoyle and Bates. It is suggested that both the pre-ionization process and the ionization by high-energy photons are operative in producing *E*-layer ionization. The former produces the normal *E*-layer and the latter (of different frequencies) intensifies the ionization at different levels producing the fine structure of the *E*-layer as reported recently. A.

551.510.535 : 538.566.3

Radio-wave propagation in the ionosphere. *See Abstr.* 337–8

551.510.535 : 550.38 : 551.54

564. Geophysical and meteorological changes in the period January–April 1949. R. P. W. LEWIS AND D. H. MCINTOSH. *Nature* [*London*] **170,** 488–9 (*Sept.* 20, 1952).

The four 27-day surges in various geophysical parameters reported by Beynon and Brown [see Abstr. 9204 (1951)] have been subjected to a rigorous statistical analysis. Using Walker's procedure for allowing for coherence among the observations, and Fisher's test of significance applied to the Fourier harmonic of period 27-days, it is claimed that whereas the noon values of *fE* probably show a significant amplitude, those of ground pressure do not. Similarly the inverse correlation between these parameters may be fortuitous. [Conclusions drawn from an analysis of only 108 observations must, however, be viewed with reserve.] G. M. BROWN

551.571.31

565. On the semi-diurnal wave of atmospheric vapour pressure. J. NEUMANN. Letter in *Bull. Res. Coun. Israel*, **2,** 67–8 (*June*, 1952).

The diurnal variation of vapour pressure is of the double wave type with the maxima and minima of vapour pressure close to the corresponding phases of the daily curve of atmospheric pressure. The correspondence is best near the equator and least in high latitudes. Fourier analysis of the semi-diurnal oscillation shows that the harmonic coefficients of the semi-diurnal waves of logarithms of pressure (*a*) density, (*b*) and virtual temperature, (*c*) form a right-angled triangle, (*c*) forming the hypotenuse. It was found that in low latitudes where (*a*) is large the phase angle of the semi-diurnal wave of vapour pressure or vapour density (*E*) is primarily influenced by the semi-diurnal oscillations of atmospheric pressure. In middle latitudes the more important influence is pressure in summer and temperature in winter. In high latitudes the decisive factor is the temperature oscillation. R. S. READ

551.576

566. The growth of cloud drops by condensation. I. General characteristics. P. SQUIRES. *Austral. J. sci. Res.*, *A*, **5,** 59–86 (*March*, 1952).

551.576

567. The growth of cloud drops by condensation. II. The formation of large cloud drops. P. SQUIRES. *Austral. J. sci. Res.*, *A*, **5,** 473–99 (*Sept.*, 1952).

The observed stability of many deep non-freezing clouds suggests that there is a gap between the sizes normally reached by droplets due to condensation and the sizes at which coalescence of drops becomes effective in producing rain. One way such clouds could yield rain would be for condensation to give rise to some drops bigger than usual. Conditions for the growth of some drops to a relatively large size by condensation are investigated theoretically. This requires that in some air parcels an undue proportion of the available water vapour should condense on relatively few nuclei. The types of vertical motion and nucleus spectra which could yield this result are investigated. Slow motions are favourable. Suitable spectra are: (i) a few "giant" nuclei ($M = 10^{-10}$, 10^{-12}); (ii) all but a few nuclei relatively small. Rain itself tends to produce type (ii) spectrum, so that it could perhaps act regeneratively. It is found that very large cloud drops can be formed by condensation under conditions which, on present knowledge, seem likely to occur at times, but not normally. The hypothesis that the factors studied here largely determine colloidal stability in non-freezing cloud is therefore satisfactory, inasmuch as it leaves room for both stability and instability. A.

551.593.6

568. Note on reflection and diffraction from ice crystals in the sky. C. F. SQUIRE. Letter in *J. Opt. Soc. Amer.*, **42,** 782 (*Oct.*, 1952).

Photographs were taken from an aircraft at 12 000 ft of the reflection of sunlight from ice crystals. The reflected image of the sun was intense. The image and diffraction ring round it were both elliptical. If wind oriented the crystals on the horizontal plane the diffraction ring could be elliptical but it does not account for the elliptical shape of the central image. The central spot was sometimes at different distances away which may be due to differing densities of the crystals while when the aircraft flew into warm air it disappeared at once. R. S. READ

551.594.14

569. Tracing nuclear explosions. N. J. HOLTER AND W. R. GLASSCOCK. *Nucleonics*, **10,** 10–13 (*Aug.*, 1952).

Airborne radioactivity precipitated in rain or snow has been measured by counter observations on samples concentrated by evaporation or filtration through cotton. A maximum half life of 10·6 hrs (Pb^{212}) is associated with natural atmospheric activity. A number of samples collected (at Helena, Montana) revealed activities of much longer decay periods. These are attributed to atomic explosions in Nevada and Russia. It is considered possible to assign a date to the occurrence of the explosion from observations of the decay curve. L. R. SHEPHERD

BIOLOGY 57/59

MEDICAL SCIENCE . HUMAN PHYSIOLOGY 61

612.741.4

570. A dynamometer for the human calf muscles. O. C. J. LIPPOLD, P. F. D. NAYLOR AND E. E. E. TREADWELL. *J. sci. Instrum.*, **29,** 365–6 (*Nov.*, 1952).

An apparatus which measures the tension developed in the calf muscles of the human leg is described. It consists of a framework, into which the leg of the seated subject is clamped, which supports a platform rotated by the foot. The pressure on this platform and hence the force of contraction of the calf muscles, is recorded by a hydraulic system. Reference is made to some of the uses of this apparatus. A.

612.843

571. Directional scattering of light by the human retina. G. Toraldo Di Francia and L. Ronchi. Letter in *J. Opt. Soc. Amer.*, **42,** 782–3 (*Oct.*, 1952).

If the Stiles–Crawford effect is due to cones acting like micro-antennae, a directional effect would have to be observed in the amplitude of the scattered light: more light is expected to be scattered into directions including a large angle with the direction of incidence. Experiments on two enucleated human eyes and the eye of the pig confirm this view, others, on the ox, oppose it. R. A. WEALE

612.843.31

572. An experimental determination of some iso-chromaticity lines in color-deficient vision. R. M. Halsey and A. Chapanis. *J. Opt. Soc. Amer.*, **42,** 722–39 (*Oct.*, 1952).

From an assortment of red and red-purple Munsell papers, 47 colour-deficient and 13 colour-normal subjects selected matches for 8 standard blue-green and neutral papers. The colour-deficient subjects were classified into the following groups: 7 protans with severe defects, 9 protans with mild defects, 10 deutans with severe defects, and 21 deutans with mild defects. For every subject the 3 colours (1 at each of 3 chroma levels) chosen as matches for each standard were plotted on the CIE diagram, and a straight line, originating at the locus of the standard colour, was fitted through the points. The slopes of these lines are significantly different for protans and deutans. Colour-deficient subjects with mild defects tend to select the same matches as do those with severe defects, but the former show more variability. In addition, matches made by subjects with severe defects are more often rated "good" or "excellent," and are more likely to fall along a straight line than are those made by subjects with mild defects. Matches made by the colour-normal subjects are most variable and never rated good. Data on the constants of the iso-chromaticity lines, the Munsell notations of the matches, and the lightness relationships are given. For all matches by deutans and for matches against neutral standards by protanopes, the agreement of the empirical lines with those predicted from spectral data by Judd is good. However, protan matches against blue-green standards diverge markedly from predictions; protans actually select colours which are yellower than those predicted from spectral data. When the data for all value levels are pooled, it appears that the iso-colour lines for some subjects may be curved rather than straight. A.

616–073.75

573. Roentgen doses during diagnostic procedures. V. W. Ritter, S. R. Warren, Jr and E. P. Pendergrass. *Radiology*, **59,** 238–51 (*Aug.*, 1952).

A survey of doses from 14 diagnostic sets over a range 40 to 90 kV and with varying filters is used to derive curves of standard dose for a fixed distance, 67 cm and 1 mm Al filter. Correction factors for distance and filter are given, so that the dose received on the skin, and at a depth, may readily be found for any given X-ray exposure. Typical results for diagnostic exposures are given. With the exception of pelvimetry, lumbar spine and dental cases, these are regarded as being within safe limits. F. T. FARMER

TECHNICAL MATERIALS 66/67

669 : 539.217

Metallurgical equilibrium diagrams. *See Abstr.* 482

PHOTOGRAPHY 77

771.3

574. A collimator with variable focal length and tilted test plate for testing cameras. P. J. Lindberg. *J. Opt. Soc. Amer.*, **42,** 748–51 (*Oct.*, 1952).

By means of a tele-objective system in a test collimator, which includes a tilted test plate with appropriately proportioned Foucault groups. it is possible to examine cameras of different focal lengths and without any mechanical modification to them. The procedure gives the tangential and radial resolving powers, and at the same time the corresponding image surfaces. Distortion may also be determined from the same test photograph. A.

771.53 : 539.234

575. Russell effect on evaporated metal films. L. Grunberg and K. H. R. Wright. Letter in *Nature* [*London*] **170,** 456–7 (*Sept.* 13, 1952).

In 1897, Russell showed that freshly abraded metal surfaces produce an image on photographic plates and he suggested H_2O_2 as the cause. [See also Abstr. 2839 (1950)]. It is now confirmed that H_2O_2 is produced whenever fresh surfaces of Al, Mg, Ni or Zn are cut under water, and that evaporated films of metals, when exposed to the action of oxygen and water vapour, can produce an image on photographic plates. An outline of the experimental procedure is included. At a given ratio of water vapour to oxygen, the optical density increases to a constant with increasing air pressure. The cause is held to be the availability of free electrons on freshly exposed metal surfaces. 1 diagram and 4 refs. H. H. HODGSON

778.34 : 537.59

A quick method of distortion measurement in nuclear emulsions. *See Abstr.* 298